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THE KING OF SIAM AND HIS CHILDREN.—From a photograph.

SIAM.

ONE of the most treacherous robberies of a nation's independence took place in July last, under the auspices of the government of France, when the people of Siam were, at the mouth of the cannon, compelled to subject themselves to the yoke of the French.

It is the same style of outrage which the French attempted upon the republic of Mexico many years ago, when they set up a pretended government there by force of arms.

Following a similar wicked line of procedure, the French are now engaged in stealing away the territory of the republic of Liberia, in Africa.

As to Siam, in a time of profound peace, in the midst of cordial relations with all foreign powers, a fleet of French gunboats steamed up the Menam River and anchored in line before the great city of Bangkok, the capital of Siam. There was nothing specially alarming in this, as the war vessels of friendly nations had long been accustomed to pay visits to Bangkok, where they were always hospitably received. But on this occasion it was noticed the Frenchmen loaded their great guns and trained them upon the royal palace and made other warlike demonstrations. Then the French minister required audience with the king, and, to his astonishment, in the name of France, demanded the transfer to that country of the eastern half of the kingdom of Siam, and the payment of several millions of money.

Only a few hours time were given to the king to decide whether he would consent to this astounding robbery rather than see his capital burned, his people destroyed by thousands, and his country plunged into the midst of disastrous war. Like all his people, of mild and amiable disposition, he shrank from the bloody sacrifice required; and at the end of the short period allowed him, with no sign of help offered by the representatives of other governments, he signified his acceptance of the French ultimatum. No sooner was this done, the money paid, and the transfer ratified than the French set up an enlargement of their demands, and it is now expected they will seize the remnant of the Siamese kingdom, put an end to her independence, and make the country an adjunct of France under the name of a colonial possession.

We herewith present a number of illustrations which may help to convey some idea of the progress that Siam has made within the last few years in civilization. It is an interesting country and it is greatly to be regretted she has become the victim of French treachery and rapacity.

Henry Norman, in the *Illustrated London News*, in a recent article entitled "A Glance at Bangkok," says: The capital of Siam is in a corner just off the regular tourist track round the world. That is why so few people have visited it. It is in itself far more worth seeing and studying than many places that everybody boasts about; but the English ships all go from Singapore to Hong Kong, and the French ships go from Singapore to Saigon, and to visit Siam one must disembark and take passage either upon a Chinese-owned steamer of so peculiar a character that no insurance company will take her as a risk, or else upon one of the little steamers of the Blue Funnel Line, which are built broad and shallow with rounded keels to pass over the Bangkok bar, with the certainty of getting a terrific shaking up if rough weather is encountered. For four days the coast of the Malay Peninsula is often within sight and the vessel's arrival is generally timed to coincide with high water on the bar, which allows a 13 foot vessel to pass up. The coast of Siam is, of course, quite flat, and the mangrove swamps, which feed on the salt water, come right down to the edge. Most European captains pilot themselves in, and the first characteristic Siamese object that meets the eye of the eager visitor is one of the most charming that he may expect to see—a delicious little temple built upon graceful columns apparently rising from the water, with the curved horned roof and tall spire of Buddhist architecture, half green and half gold, and, what is rarest of all in the East, in excellent preservation. From the bar to the city is about twenty-five miles, but long before the latter is reached you pass on the one hand the huge rice mills which provide half the export trade of Siam, while from the other comes the buzz of the teak saws which provide the other half. The steamer will probably moor alongside one of these, and you will be transferred into a steam launch to go to the hotel or the consulate.

The river scene is one of the busiest and most exciting in the far East; hundreds of boats cross and recross in all directions; little steam launches puff their way busily about, the house boats of the foreigners and the well-to-do inhabitants glide quickly by, propelled by a huge oar in bow and stern; the open boats of the Chinese peddlers, containing a little of almost everything on earth, pass from house to house, and, most curious of all, scores of little canoes carry the women of Bangkok on their errands of business or pleasure. For in the Siamese *menage* it is the woman who rules, who receives and pays money, and who conducts all the business of the family. Siam is a nation of short-haired women, both in fact and in significance.

The houses of Bangkok do not stop at the edge of the river; they occupy half its breadth, and at least a quarter of the population lives afloat. In fact, many a Siamese who has come to Europe as a prince or a count or a baron, to hobnob with crowned heads and to be received with guards of honor, lives, when he is at home, in a little bamboo-built house of two rooms, erected on a platform of floating bamboos. Under these circumstances it is unnecessary to speak of the condition of the river, and as it is the sole source of drinking water in a city of teetotalers, King Cholera holds high revels in Siam. Europeans occasionally die of it, and hardly anybody spends a year in Bangkok without having dysentery, which is almost as bad.

The telegraph has described the French gun-boats as anchoring off the British Legation—a statement calculated to convey a much more warlike notion than the facts warrant. The excellent little hotel, owned by a German and a Swede, the new building of the Hong Kong and Shanghai Bank, the Legations of England, France, and Germany, the Custom House—these are all collected in a group upon the river front, and any visiting vessel or yacht would, in the natural course of things, anchor opposite them. The Siamese fort, I should have said, is much lower down the river; and, higher up, what is euphemistically called the Siamese fleet is permanently moored. Most of the vessels composing it have been boarded over to provide accommodation for sailors, almost all of whose duties are performed ashore, and it is years since steam was got up in their boilers. The collection of buildings I have described constitutes the principal part of what is called the Foreign City; the Siamese City is three miles higher up, and is reached either by boat or by a long straight road. No well-to-do Siamese live in the Foreign City, and most Siamese princes and government functionaries do not set their foot in it once a year. Neither, on the other hand, do the European residents who are engaged in business visit the Siamese City, except to show its curiosities to their visitors, or to call at the Foreign Office on some matter requiring government intervention. The European, not in the Siamese service, who goes and lives in the Siamese City as I did, is regarded as deliberately and not very politely cutting himself off from the society of his fellow countrymen.

The best way to see Bangkok is to climb to the top of a queer artificial hill called the Golden Mount, when the city lies spread out in a panorama around you, the most striking feature being, of course, the network of canals. The roads in the native city are of secondary importance, all the traffic is done by water, and the most interesting glimpses of private Siamese life are to be gained, if you are a canoeist, by procuring a native boat and paddling yourself in the cool of the morning or evening through the labyrinth of waterways. It is this characteristic of Bangkok that caused the first European visitor—and every subsequent one—to call it "The Venice of the East." From the top of the Golden Mount you realize how large a part of the enterprise and interest of the Siamese runs in the direction of religion, for in whatever direction you stretch out your hand you will be pointing to three or four "Wats," as the temples are called, all gorgeous, like the little river temple, in crimson and green and gold, but of varying sizes, from the great Wat Chang to the quaint and pretty little Wat Anong, and in various stages of preservation, from the beautiful temple inside the Royal Palace down to others which are mere decaying ruins. For a Siamese temple, except the royal one, is never restored; in the Buddhist faith no merit attaches to restoring another man's Wat, and the seeker after celestial welfare must build his own. Most travelers have something of the ghoul in them, and, therefore, they are always taken to see Wat Seket, the City Cemetery of Bangkok, where the rich are cremated and the paupers are thrown naked into an empty space and eaten by dogs, pigs, and vultures, the attendant having previously obligingly slit them open to facilitate the process.

The Royal Palace is the most beautiful building between Singapore and San Francisco, the Italian architect having very cleverly united the European and Siamese styles of architecture in one building, the lower part, of white marble, containing elaborate offices and reception rooms, and the upper part displaying the fanciful and gorgeous roof of the Siamese temple. This, however, is only the palace that is shown to foreigners; the real palace, where the King's innumerable household reside, being a small town behind this fine building, carefully surrounded by a wall, and absolutely secluded from the inquisitive eye and foot of the visitor. To such a point is the spirit of exclusion carried that good manners require you instantly and bluntly to turn your back upon any Siamese princess whose carriage may by chance pass you in the street. Compliance with this rule is much appreciated by the Siamese, and the staring foreigner is proportionately detested. No description of Bangkok is complete without a few words about the king, who is certainly its most charming inhabitant. He is a handsome man, of as commanding a presence as is possible to small stature; his behavior to those foreigners whom he likes is characterized by dignified and charming familiarity, and he has a full measure of the traditional royal faculty for remembering names and personalities and always saying the right thing. Any one who has had the honor of seeing much of him will have an extra reason for regretting if French ambition should result in his downfall.

DISCO ISLAND, SOUTH GREENLAND.

By WM. E. MEEHAN, Member of the Peary Relief Expedition.

THE first putting foot on the shores of the island of Disco, South Greenland, in summer, must cause surprise and delight. Everything is so different from the popular notion of the region above the arctic circle. There exists in the minds of most people an idea that in Greenland the temperature is at all times below the freezing point; but a visit to that land in June, July, or the early part of August will quickly correct that idea.

When the Peary relief expedition landed at Godhaven, a Danish settlement on the island of Disco, in July of last year, those of us who composed the party found the air almost oppressively warm; but, beyond being attacked by mosquitoes with great ferocity, we found nothing forbidding, and little to give force to the name of the "Land of Desolation," bestowed by honest old John Davis in 1585. Indeed, had it not been for occasional glimpses of a shining glacier, high up among the red cliffs, of the ice cap, of small patches of the previous winter's snow in shady gulches, of the great icebergs which floated majestically on the rippling waters of Disco Bay, and for the dirty, lazy half-breed Eskimos about the settlement, there would be little to give a reminder of what is commonly called the frozen north. In every nook and cranny in which the sun could shine, purple, yellow and white flowers were in profusion. Dandelions and buttercups, pyrolas and poppies, epilobiums, potentillas and other familiar home flowers, vied with each other in their plenitude of bloom.

In the valleys the feet sink ankle deep in sphagnum and clump moss, while in and about the settlement bright green grass was knee deep. Trees were missed only. True there were willows and birches by the million, covering the naked rocks almost to the ice cap itself; but they were not more than six inches high, although they each spread creeper-like over a radius of several feet. Taking it all in all, there are many places in Pennsylvania and other States less charming and more uncomfortable than is this spot, more than two hundred miles above the arctic circle. Observing and feeling the effects of the short Greenland summer with its lovely floral display, and hearing the gladsome twitter of multitudes of small land birds, and suffering from the ferocious attacks of millions upon millions of hungry mosquitoes, it is hard to believe the statements made of the terrible nature of an arctic winter, when the temperature is said frequently to fall sixty degrees below zero.

The island of Disco is the largest of the innumerable land masses which line the west coast of Greenland. It is nearly one hundred miles long and rises for the most part in sheer precipices from the water's edge to heights of from seventeen hundred to two thousand feet. Its flat interior is almost entirely buried by a deep ice cap, which finds an outlet for its surplus material in numerous glaciers, which empty into large flords indenting the coast.

There is a legend among the Eskimos that Disco Island did not always occupy the position it now does. According to them, it was once located far away in the south, where the snow never falls, and where the weather is eternally warm. Then and there the island teemed with game, and it was a favorite hunting ground for the natives of the mainland. But one day, the legend runs, these natives insulted Ewafki, the most powerful of the many evil spirits, and, consequently, a highly esteemed personage among the southern Eskimos. Like all evil spirits, Ewafki became deeply angered at the conduct of the insolent southerners and resolved to revenge himself on them in a more terrible manner than if he ate them, bones and all, the usual course pursued on like occasions by a brother evil spirit, Korkoya by name. Jumping into his kyak, Ewafki rowed to the island, where he drove his harpoon deep into the rocks and then towed the beautiful piece of land away to where it now is, thus depriving the natives of the south of their principal means of livelihood. The hole made by Ewafki's harpoon may yet be seen, it is said, in the great cliffs on the north side of the island, where Waigat Straits join the sea.

As if to bear out the truth of this pretty legend, there is much and indisputable evidence to show that the climate of Disco Island was at one time at least temperate, if not actually tropical, to an extent not found elsewhere in Greenland, it is asserted, except on the west shores opposite Waigat Straits. These proofs consist among other things in numerous coal beds of considerable thickness, and of petrified woods, and leaves belonging to trees that grow to great size. The coal is of poor quality, it is true, nothing but lignite, but it indicates much the same climate which prevailed when the better quality of carbonaceous material in other places was being formed, because comprising similar matter.

It is the remains of and impressions of leaves, however, which furnish the strongest evidence of a once more genial temperature, for these leaves are of chestnuts and poplars, both genera now existing in the temperate zone. Curiously enough, there are also found leaves of the maidenhair tree (*Salisburia adiantifolia*), a carbon-resisting tree growing now in a cultivated state only (having become extinct as a wild tree), but found plentifully in the coal measures in different parts of the world.

Apart from these signs of a more tropical climate, Disco and its immediate land neighborhood possess more than usual interest to the student in geology.

It has been pretty definitely settled that the southern half of Greenland is slowly sinking beneath the sea, while the upper half is at the same time rising. Numerous settlements, from Cape Farewell and for many miles above, once well beyond the water line, are now almost washed by high tides. On the other hand, from below Cape York and northwardly the shores of the bays and fiords mostly rise in a series of terraces above the water, each two and even three hundred feet. These terraces evidently are old beach lines, for they are not only for the most part of a sandy nature, but they abound in marine shells of the kinds now found in arctic waters. That these terraces were all not formed at the same time is also shown through these same shells, which become more brittle and broken the further away they are located from the present water line.

Greenland then may be likened to the huge walking beam of an engine, and to make the simile stronger, Disco and the land eastward seem to be the pivot on which it works. Above and below Disco the prevailing rock formations are sandstones or clays, through which basalt has been thrust at frequent intervals by volcanic convulsion; but for some miles north and south of Disco, and extending eastward, probably clear across the great arctic continent, granite also projects itself above the normal surface.

On the south side of Disco Island juts, in a semicircular form, a low peninsula inclosing a narrow but deep body of water, to which the Danes have given the name of Godhaven (good harbor). On this peninsula and on the shores of the little harbor nestles Lievely, better known as the settlement of Godhaven.

A mile or two to the eastward a river of almost crimson hue dashes, foam-beaten, into Disco Bay, staining the latter's blue waters for a long distance from shore. This stream (called Rothe or Red River) has its rise through several branches in the ice cap; and its course is southward through a grandly picturesque valley which has been rightly named Blauzy Dael or Windy Valley. The several arms of the Red River have torn for themselves deep and winding gorges and great caverns in the basaltic rocks which here crop out. Through them the water rushes madly, and falls of rare beauty abound. The second of these above the mouth is more than a hundred feet high, and over this the water sweeps in an unbroken sheet with loud roarings into a large semicircular pool, from which mist is thrown in such heavy clouds that the lower portions of the cataract are almost entirely obscured.

One of the arms of the Red River has been called the Devil's Hole. For three miles or more the scene here is what one might readily believe to be taken from the workings of the infernal regions. Not more than a few yards wide, the gorge or hole is from one to three hundred feet deep, and here and there only glimpses can be had of the blood-red waters lashed into scem-

ing fury rushing over the bottom. For the most part, however, the eye fails to see anything except jagged rocks, which protrude by the thousand from the sides of the rift; but to the ears are borne hollow roarings, and horrible sounds of crunching bowlders being rolled, tumbled and broken by the torrent.

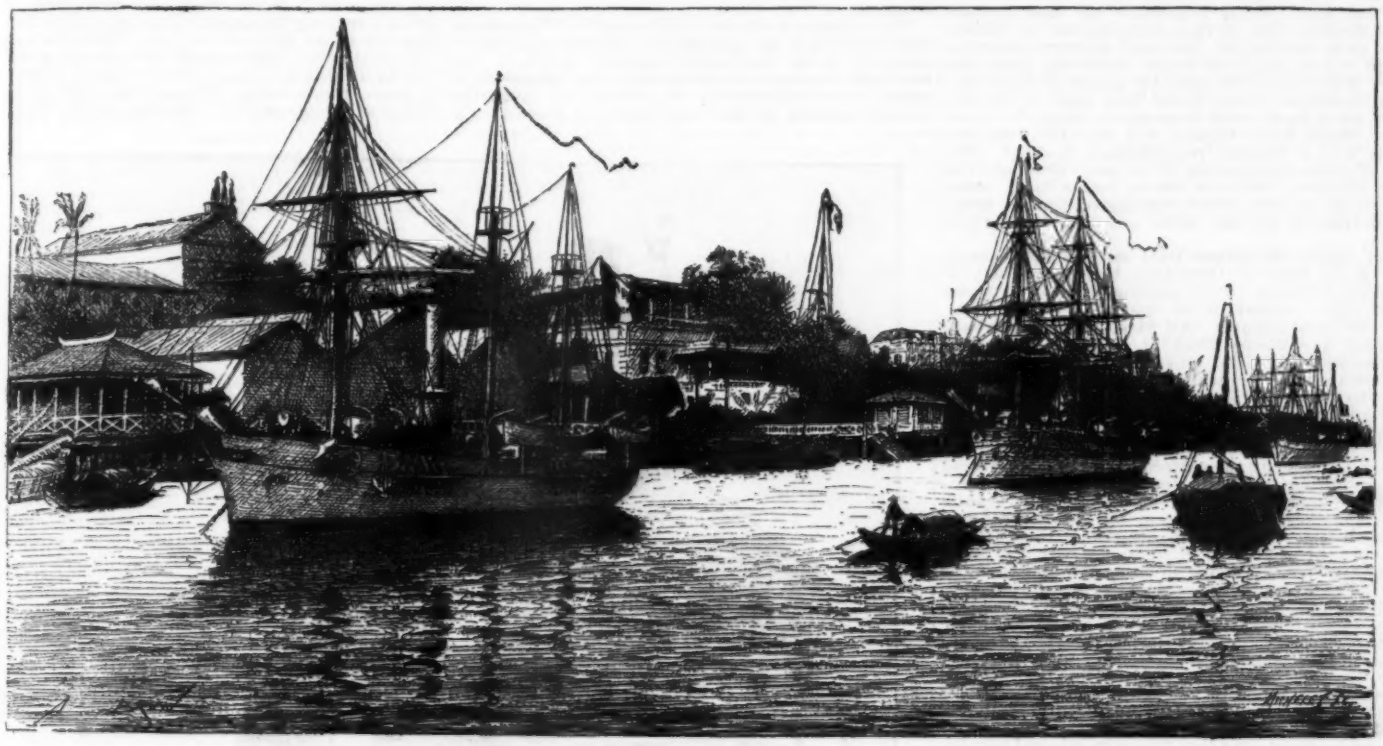
The Windy Valley was once the site of a mighty glacier, but through some climatic change, or cause unknown to scientists, this great body of ice was driven back with great rapidity until now scarce anything is left of it other than its frozen headwaters, ten or twelve miles back from Disco Bay; and nature is even yet forcing it further toward the ice cap from which it came.

In the place of this huge river of ice have sprung flowers, moss and the few hard-wooded plants which thrive in the far north. These have buried the hideous ground moraine completely with an emerald mantle, plentifully dotted in the summer time with gold, crimson and white blossoms, among and over which myriads of butterflies, moths and stingless bees flutter as gayly as in more temperate and tropical climes.

Some four miles from Disco Bay in Blauzy Dael is a singularly pretty lake, perhaps a quarter of a mile long and half that distance wide. It is formed by the melting snows from the higher level. Clear as crystal the waters are, and though deep the bottom can be plainly seen for some distance from shore. When this fairy-like body of water was come upon first by the members of the Peary relief expedition not a ripple distured its clear, cold bosom, and a lofty mountain which rose majestically behind it was reflected from its surface as from a mirror.

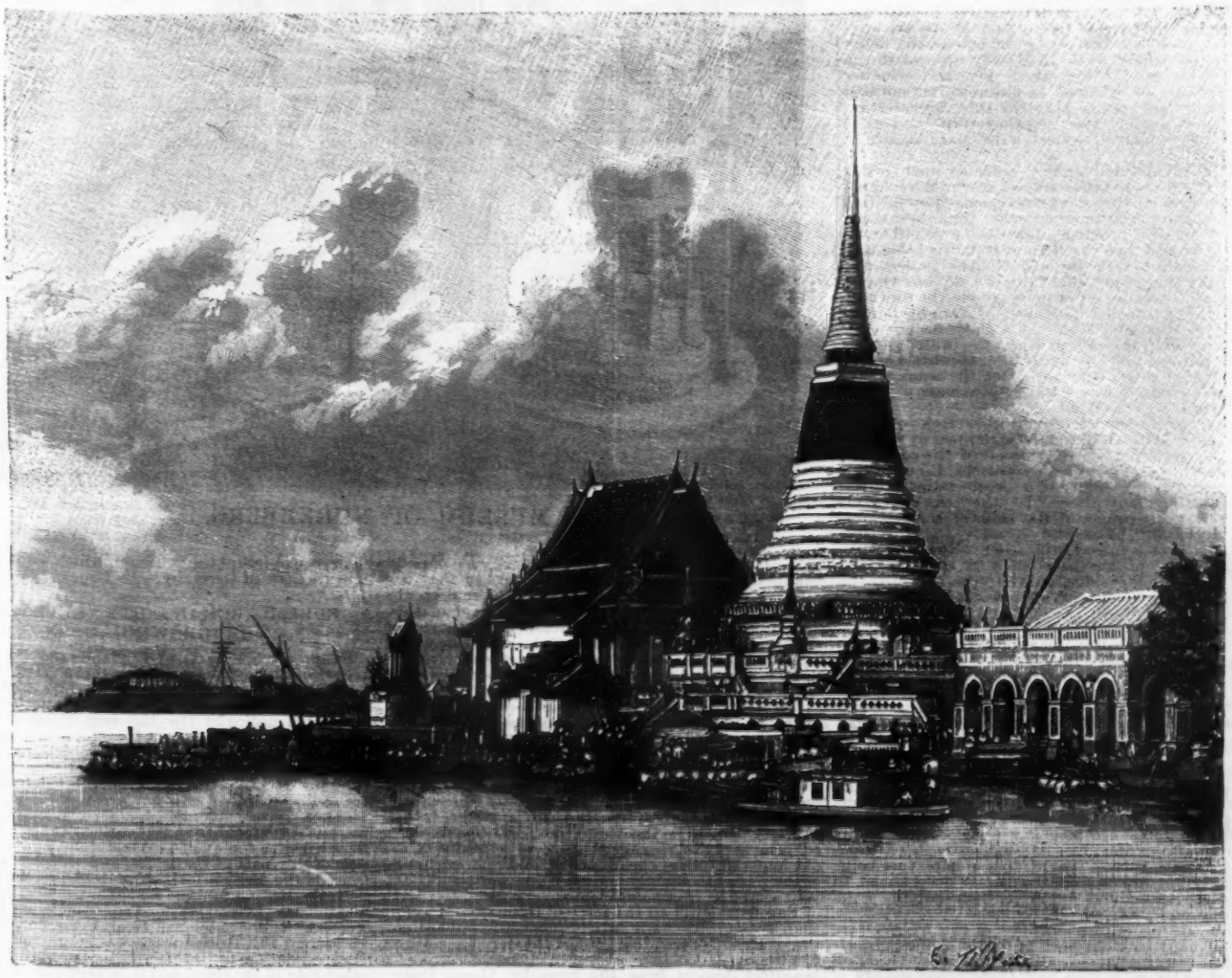
This mountain is the first of a series of huge square mounds of red basalt which line the east side of Blauzy Dael, at almost regular intervals, clear to the ice cap, which gleams like white marble in the distance. All the space between these great square mountains had once been occupied by glaciers, tributaries to the enormous one which at one time flowed through Blauzy Dael to Disco Bay; but, like it, have been driven back by Nature's mysterious hand to the ice cap.

The west side of Blauzy Dael rises in sharp and



Lutin. The Consulate General. Inconstant. Comete.

THE CRISIS IN SIAM—FRENCH MEN-OF-WAR ANCHORED OFF THE FRENCH CONSULATE GENERAL AT BANGKOK.



FORTIFIED ISLAND AND PAGODA OF CHEDI-PAK-NAM, ON THE MENAM RIVER, SIAM.

irregular peaks, as though broken off suddenly by some terrific force; and on their sides and along their bases are huge bowlders and mounds of smaller debris thrown from the summit by ice and floods in the spring.

Far up one of these peaks, extending northward toward its neighbor, but broken in twain before reaching it, sharply silhouetted against the sky, is a great bulwark of small and large stones, a hundred or more feet high. This is a terminal moraine, and the glacier which formed it, though driven backward like its brethren in the vicinity, still glowers threateningly half a mile above.

This body of ice, like nearly all valley glaciers, whether receding or advancing, spreads out like a huge fan, with a face between eighty and one hundred feet high. From a distance the mass appears almost flawless; but on close examination its surface is seen to be seamed by crevasses in every direction, though few of them are large. Climbing upon this glacier with much difficulty, by means of one of the lateral moraines, it was found that many of the crevasses have their sides abundantly lined by huge icicles, which, when broken, fall into the unknown depths with a musical ring pleasant to hear. The walls of these crevasses are of an azure blue, and the icicles colorless, white or brown, some huge, some small, some smooth, others corrugated, form a striking contrast to it, and make a scene of wondrous beauty.

Such valleys as Blauzy Dael are common enough along every fiord of Greenland, but particularly on the island of Disco. They are the oases in the waste of ice, the rendezvous of reindeer, arctic hares, foxes and other animals. All these valleys have been occupied, like Blauzy Dael, at one time or another by glaciers. All have still the remains of one or more within their boundaries, either clambering back slowly to the eternal ice cap which gave them being or advancing with greater or less rapidity once more to stamp out the vegetation with its crushing force, and empty their frozen masses into the sea.

The scenery along the western shores of Disco Island is as interesting and grand as it is varied. Many fiords break the huge wall of red basalt and gray granite which rises precipitously from the sea nearly two thousand feet. These fiords sometimes thrust themselves inward almost at right angles with the land; but more often they work in obliquely, and then the abutting rocks stand out as sharp as gigantic wedges.

One of the most remarkable of these places is Sertok Point, which forms the dividing line to the south entrance of Disco Fiord. Here the two sides of the mountain meet in a "hog back" extending from the water line to the table land in so sharp a line that no man can stand with safety on its edge at any part.

Near this point is found an extremely curious mineral called tellurite, which is said to exist in no other part of the world. For a long time this rare mineral was believed to be meteoric iron, which it resembles in many particulars, including the magnetic properties of the latter. But later investigations have shown it to be of volcanic origin and thrust out at the same time with basaltic rock, much of which substance is found mixed with the mineral itself.

Not far from this point, it is said, two Englishmen lie buried on the narrow beach, just above the high water line, near the outer edge of one of the many small gullies which work their way upward to the interior table land. Who these men are, whether early explorers or whalers, is unknown, as nothing marks their last resting place in this desolate, ice-bound spot except two weather-worn and rude crosses, from which all letters have long since been obliterated.

Most of these small gullies, such as open a way through the rocks to these graves, are in the summer time pathways for turbulent streams made by melting inland ice, and the latter is not whiter than these foam-beaten rivers which plunge down the precipitous inclines. Now and then the streams from the table land seem to disdain to seek the aid of these gullies, and spring over the great cliffs into the ocean. One of these erratic streams, a few miles above the southern end of Disco, tumbles in almost a straight line for nearly two thousand feet. At a short distance, for more than half this awful leap, the water shining against the red cliffs presents the appearance of a broad band of silver, and then, for the remainder of the way, it expands into a wide, white mass of spray, as delicate as a cirrus cloud.

As much of the sandstone and other rocks of Disco Island have red basalt thrust through them by volcanic action, a greater part of the summit of the coast line offers a beautiful and fantastic spectacle. Innumerable pinnacles, like the spires of a great cathedral, rise heavenward in many places. In others the upheavals present the appearance of the ruins of a great city. Again the basaltic blocks rise one above the other, like the ramparts of a huge fortification. Now and then some gigantic force has been at work, and hollowed out a vast amphitheater, on the sides of which the basaltic rocks rise in curved terraces, like seats for giants.

Thus, the whole coast line of Disco is a series of delightful and impressive panoramas, so constantly changing that satiety is impossible.

Not less curious or interesting to the traveler about Disco are the innumerable icebergs which there float silently by, close to the shore, in regular and majestic procession to Melville Bay, their whiteness seeming much whiter by contrast with the red rocks of the cliffs.

These bergs maintain nearly a single file, almost as rigidly as though guided by regular military rule. As far as the eye can reach, north or south, this silent procession reaches. At almost regular intervals apart the ice mountains are of gigantic proportions, while the intervals are filled by small masses of say a thousand tons or so each in weight. These miniature bergs are fragments broken from the greater mass ahead, to fall to the water and follow in their parents' wake like children.

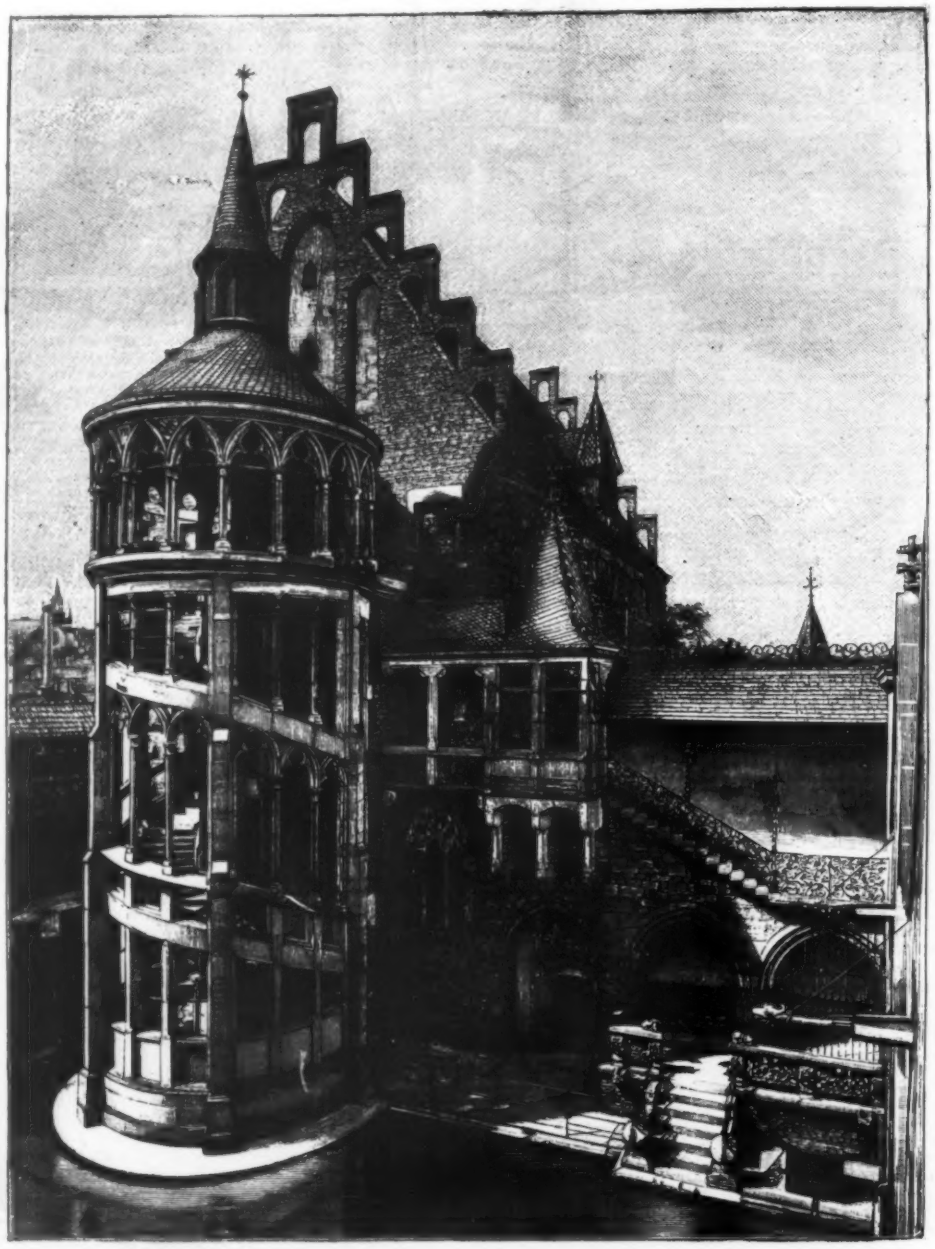
While the prevailing outlines of the icebergs are cubical, many take on most fantastic shapes, objects animate and inanimate, all have representation in pure white ice, with here and there broad streaks of azure running across their faces by way of striking contrast.—*The Independent.*

THE MUSEUM OF NUREMBERG.

OUR engraving represents one of the interior courts of the Museum of Nuremberg. The curious thing about this court, and what especially strikes the visitor, is that it is filled with water, as may be seen from the gargoyle that empties into it to the right of the engraving. When a person comes out of one of the halls of the museum, or descends the staircase in the tower to the left, he experiences a singular impression upon suddenly meeting with a basin in the midst of buildings closed on all sides.

The basin is supplied by a chimera spitting out water by great mouthfuls, and which faces the portion of the building here represented. This odd court is not one of the least curiosities of the Germanic Museum.

This museum is situated at the south of Nuremberg. The collections are installed in a Gothic Carthusian nunnery of the fourteenth century, in which very beautiful cloisters are preserved, and alongside of which was reconstructed a convent of Augustine monks replaced by the new palace of justice. The



MUSEUM OF NUREMBERG.

Nuremberg architects have been able to very happily combine the modern with the ancient, so that the parts of the building construc ed at different epochs accord harmoniously. To give but one proof of this, the tower that contains the staircase is modern; but were it not for the whiter shade of the stone one would believe that it also dated from the fourteenth century. Moreover, we find everywhere at Nuremberg the same taste in the restoration of the middle age. Unfortunately, the good bourgeois do not hesitate to install a café or a post office in an edifice of the purest Gothic. Here, at least, the buildings are not profaned by the use that is made of them.

The museum, which was founded by Baron d'Aufsess in 1852, contains a little of everything, up to a small harmless bear, which contemplates with a melancholy eye an inscription in three languages forbidding anything to be thrown to him. But it was founded principally to recall the epoch of splendor of the old imperial cities—the fifteenth and the beginning of the sixteenth century—when Nuremberg and Bamberg served as *entrepots* between Venice and the north of Europe and did all the trade of Germany. In more than seventy-five halls or cloisters are found antiquities of all sorts: paintings of the old German masters, of Etienne de Colonge and of Wohlgemuth and of a beautiful descent from the cross by Albert Durer; sculptures on wood by Veit Stoss and bronzes by Pierre Vischer, the founder. But the interest of the museum consists especially in the large collection of objects borrowed from the industrial arts which make known to us the intimate life of a bourgeois of the period.

In addition to the furniture, the fabrics, the jewelry, the ironwork, the arms and the mouldings of the principal monuments and most beautiful fountains of Nuremberg, the museum contains illuminated manuscripts, early printed works, more than twenty thousand engravings upon wood or metal; maps, plans, mathematical instruments, ancient watches, called "Nuremberg eggs," on account of their form; and, finally, albums and manuscript text books and recipe books, which are not the least curious objects. There has even been restored the shop of a lute maker, the chamber of a notable of the time and the kitchen of an alchemist. Better than any other, this museum gives a striking impression of bourgeois life and of the customs of the fifteenth century. So it is with good reason that the organizers of the museum gave an order to Kaulbach to paint in the chapel of the cloister a fresco representing Emperor Otho III. opening the tomb of Charlemagne. Nothing could better symbolize the object of the museum, which is to bring to light the past of Germany.—*Le Magasin Pittoresque.*

A BURIED ROMAN CITY REVEALED BY THE GROWING CORN.

THERE are few parts of England possessing greater historical interest than the neighborhood of Earl's or Long Wittenham, a village four miles southeast of Abingdon. Recently it has been brought prominently into public notice by the discovery of extensive indications of Roman occupation, and it seems highly probable that further investigations may show that this spot was the site of a Romano-British camp or military station. The beauties of this spot, familiar to all who are well acquainted with our great British river, the Thames, have evidently rendered it an attractive place of settlement from the earliest times. It is surrounded with the quiet pastoral scenery so characteristic of this part of Berkshire, and within a short distance is the British fortress of Sinodun, fortified by both the Britons and the Romans, "wonderfully diked about," as Leland says, and "hanging over the Tamesi." In the opinion of Hearne, the learned Oxford antiquary, this British work was connected with the Roman station at Dorchester ("Darocina"), on the other side of the river, but it is very possible that the locality indicated by the remains recently found may have been the site of the camp the Romans fixed here

in order to storm this strong position of the natives. The deep trench of the British earthworks still surrounds the summit of Sinodun, inclosing now the fine clump of trees which renders it the principal object for the eye to rest upon along the course of the winding river. In this same parish of Wittenham an extensive Anglo-Saxon cemetery was discovered some years ago, and it yielded most interesting results, described by the late Mr. J. Yonge Akerman, F.S.A., in vols. xxxviii. and xxxix. of the *Archæologia* of the Society of Antiquaries.

The fields over which these vestiges of Romano-British occupation have been found comprise about sixty acres; and during the recent extraordinarily dry season Mr. Hewett, the occupier of the farm, noticed for the first time that the corn showed greater fertility in some parts of the fields than in others, and that the outlines thus formed appeared to represent the foundations of extensive buildings, roads, and openings, of very considerable extent and variety of plan. In the middle of the squares and circles the corn was comparatively stunted, and did not flourish so vigorously as on each side of these blocks, which by this means were readily distinguishable. Near the middle of the field a spacious inclosure is distinctly marked in a crop of barley, at the intersection of what appear to be several main streets, in form very similar to the basilica at Silchester, with an apse end and courts on either side. But it is impossible to form any decided opinion as to its real character until the lines have been explored.

Thinking he would ascertain the nature of one of these marks in another part of the field, Mr. Hewett removed the solid upper soil to the depth of about eight feet, and curiously enough came upon a Roman well, about three feet in diameter, the sides of which are lined with rough, coarse blocks of Clifton rockstone, laid upon an oak curb, which was found in an almost complete state. Having removed the superincumbent *debris* Mr. Hewett descended into the well, and groping about carefully with his hands in the sandy deposit beneath the water, succeeded in taking out five perfect or nearly perfect Roman vessels of a bluish or grayish black color—all characteristic examples of what is known as Upchurch ware. This pottery is so called because made on the tract of land now known as the Upchurch Marshes, on the River Medway below Chatham. The forms as well as the sizes vary, but we recognize them at once as coming from the hands of the Roman artist. A large quantity of necks, bases, rims, and handles of jars, jugs, and bottles were also found, together with the base of a Samian bowl, impressed with the potter's mark, AVITVS. F. Fragments of many other vessels have also been picked up in the field, and with the vases are in possession of Mr. Hewett at North Field Farm, of which this land forms a part. It should also be added that portions of a small oak bucket were found in the well.

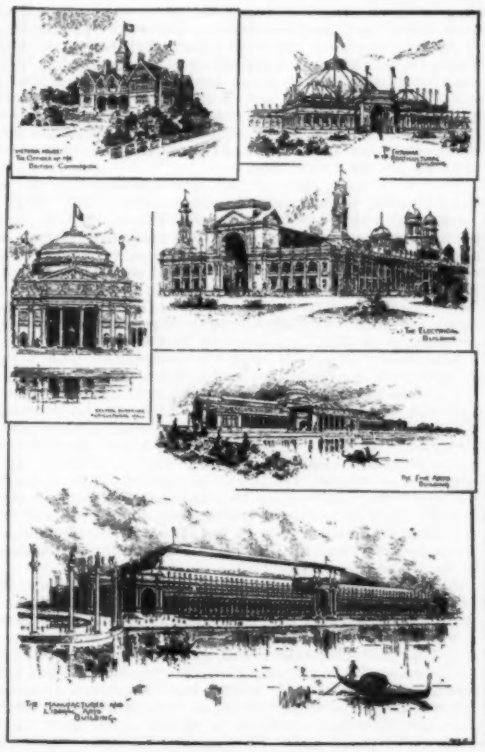
Another singular discovery must be placed on record. Some lines in the waving corn at a considerable distance from the well induced Mr. Hewett to dig underneath, and his investigation brought to light, buried in the natural soil at a depth of about two feet from the surface, a large quantity of fine white lime as pungent to the taste as though made yesterday, and over 100 bushels were taken out in one day. Such deposits of lime have been before discovered on Roman sites, but it is difficult to hazard a conjecture as to the purpose for which they were made and preserved. The perfect condition of the deposit precludes the supposition that it was mere surplus material left accidentally from an adjacent building, but points rather to the notion that this was a receptacle or store for lime, either abandoned hastily or purposely reserved for exportation or employment on the spot. A piece of Roman glass was picked up near the well, also bones of oxen, sheep, swine, and deer, with horns of the domesticated Roman ox (*Bos longifrons*), and portions of human bones. But traces of a still earlier people are met with at almost every step we take, and Mr. Hewett recently found a very fine stone celt, roughly chipped, in this same field; in short, on every hand the ancient masters of the soil have left us some memorials of their settlement in this historic district. The site of the discoveries being under cultivation, the lines to which allusion has been made can only be followed by the difference in the crops, and in order to preserve these lines before the corn is cut and carried a ground plan is being prepared to scale of these indications, so that after the harvest excavations may be resumed—two or three small openings only having been made up to the present time.

When at Long Wittenham the visitor should not fail to see the interesting church in the village, which has good decorated and early English parts, and a chantry chapel of early decorated work on the south side. In this chapel there is a very curious enriched piscina and monument combined, having a diminutive cross-legged figure of a knight in armor lying along the font of it on the edge, with a basin behind it. The font is of lead, circular, standing on a massive stone base. It is transition Norman, having small circles of foliage and a row of figures under pointed arches. There are two other leaden fonts of similar character in the immediate neighborhood at Dorchester and Warborough.—*London Daily Graphic.*

THE WORLD'S COLUMBIAN EXHIBITION: A GENERAL VIEW.

THE exhibition which is being held this summer in honor of the four hundredth anniversary of the discovery of the American continent by Columbus is naturally of the greatest interest to architects all over the world; for herein are contained the efforts of the best known and most distinguished of the American architects, and it is in consequence a gauge of the standard of American contemporary architecture. In future articles we propose to treat of the buildings themselves from an architectural standpoint, but before doing so it will be best to glance shortly at the history of the conception, after the fight for supremacy between New York and Chicago as to which would have the honor of holding the World's Fair. On February 24, 1890, Congress finally decided in favor of Chicago, and immediately various sites were naturally put forward as being most suitable for the purpose of the Exhibition. One site in particular specially commended itself to a certain section. It was situated practically in the city itself, and consisted of a long, narrow tract of land on the banks of Lake Michigan, and forming the eastern boundary of the city. It was soon demonstrated, however, that this site was quite insufficient for the purpose, and that one of more ample dimensions should be selected. It thus came about that Jackson Park, a large tract of land two and one-half miles in length, running north and south, and having an area of some seven hundred acres, situated to the southeast of the city, and bounded on the east by Lake Michigan itself, was finally selected. It is at a distance of some seven miles from the heart of the city, but is easily accessible both by land and water, being reached by a special service of trains in fifteen minutes. The approach by steamer, although taking longer, is better for approaching the Exhibition for the first time, as one obtains a *coup d'œil* of the buildings which is especially fine, and which is not obtainable by rail.

The site is in many respects an ideal one for such a purpose. The waters of this great inland sea, some three hundred and sixty miles long and sixty miles across, have been enabled to be utilized for the various necessary purposes of such a large undertaking, and were also available for the creation of lakes and basins in the grounds, and for the display of ornamental fountains. A large portion of the site, whose longitudinal axis runs north and south, was covered with an undergrowth of shrubs and trees, and the remainder of the ground was of a swampy or marshy character, which of course had to be taken in hand seriously before it could be made presentable as a park in which to place the buildings. The well-known landscape architect, Mr. Frederick Law Olmsted, who, with his late partner, has laid out several of the more important public parks in America, was consulted, and eventually given the commission of arranging the grounds, and he has shown great skill and taste in transforming what was



SKETCHES AT THE WORLD'S COLUMBIAN EXPOSITION.

originally a dreary waste into a really well laid out park, in which the formal and the picturesque are well blended and adapted to the treatment of the surrounding architecture.

It is interesting to note the various preliminary proceedings in connection with the selection of architects and the procuring of designs. Messrs. Burnham & Root, of Chicago, were consulted in the first place, in conjunction with Mr. Olmsted, the landscape architect to the Council of Administration, as to the general laying out of the architectural scheme and position of the buildings. Mr. Root unfortunately died soon after their appointment, although not before he had given some valuable assistance in the original conception. It is a curious coincidence that the junior partner of both the original firms who were called in should have died soon after their appointment. It was then decided, and it is an important point for architects, that they should be selected not by public competition but by selection, and by knowledge of their fitness for the work to be intrusted to them.

Another point militated against public competition, viz., that the time was short, and the amount of work to be performed was large. Harmony in working together was also of the first importance, and it is an interesting fact that many of the architects were trained in Mr. Richard M. Hunt's office, while the others have been connected with men who have worked under him, so that there was every reason to hope for some continuity in their design, and they would also naturally work with harmony under one whom they recognized as their self-elected chief.

A council of these selected architects was established ten in number, five from New York and the East, and five from the West of America, principally from Chicago, and various meetings were held when the designs of the various buildings were allotted. Mr. Hunt, the Royal Gold Medalist of the Royal Institute of British Architects for the present year, and the Nestor of the architectural profession in the States, by common consent was given what was considered the most important design, and which was to form what would really be the great entrance portal of the Exhibition, viz., the Administration Building. To the New York architects were appointed the principal building abutting on the great Court of Honor running west from the Administration building to the lake. The Machinery Hall was given to Messrs. Peabody & Stearns, of Boston; the Agricultural Hall to Messrs. McKim, Mead & White, of New York; the Manufactures building to Mr. Geo. B. Post, of New York; the Electricity building to Messrs. Van Brunt & Home; and the Mines building to Mr. S. S. Beman, of Chicago.

To the Western architects were given the buildings surrounding the northern picturesquely treated lagoon, which has an island in the center, rustically treated in an irregular manner, and which is quite independent and different in that respect to the Grand Court of Honor on the south, which is architecturally treated and formal in its character. The Transportation building was allotted to Messrs. Adler & Sullivan, well known in connection with steel frame buildings in Chicago; the Horticultural building to Messrs. Jenney & Mundie, of Chicago; the Fisheries building to Mr. Henry Ives Cobb, of Chicago; and the Art building to Mr. C. B. Atwood, of Chicago. So much for the general settlement of the designs, of which more anon. Mr. Daniel H. Burnham, as the Chief of Construction, is responsible for the carrying out of the designs in their entirety, and for any constructional works which might be connected with them, such as the iron roof, foundations, etc., in which he has been ably assisted by Mr. Shankland.

Mr. Burnham took up his residence on the grounds in the early part of 1891, and organized his staff, and the buildings have been carried out by him with every deference to the architects' wishes in relation to their designs. Mr. C. B. Atwood, of Chicago, although not among the original selected architects, was appointed designer-in-chief to the Exhibition, for the large amount of architectural work which always exists in an Exhibition of this kind, such as the terraces, rostral columns, etc., and to him was also intrusted the design of the Railway Terminus to the west of the Administration building, the peristyle at the extreme east of the Great Court, with the Casino and Music Hall on either side; the Art building in the northern part of the grounds; and other smaller buildings, such as band stands, etc.

As has been mentioned, the main or longer axis of the Fair grounds runs practically north and south, and at right angles to this, therefore striking east and west, is the axis of the Grand Court of Honor, one thousand five hundred feet in length and about seven hundred feet across, around which the great buildings are regularly grouped, and which contains in the center and running its whole length into Lake Michigan itself. The great central longitudinal basin is connected at its northwestern point with the Minor Canal, which runs north and connects with the picturesquely laid out lagoon, and is taken south as far as the colonnade which screens the exhibit of live stock, and which serves to connect the southern ends of the Machinery and Agricultural buildings.

A large tract of land, one mile long and six hundred feet wide, known as the Midway Plaisance, runs from the head of the lagoon in a westerly direction, and contains various side shows and villages of different nations, which, although interesting in themselves, are not architecturally of much importance.

The basin to the Great Court is laid out in an architectural manner with terraces at different levels, and screened from the water itself by a low balustrade, except where the landing stages occur. Groups of statuary occur at well-defined intervals. Immediately in front of the Administration building is the Columbian Fountain, designed by Mr. F. MacMonnies, and erected by him principally at his Paris studio; it follows somewhat on the lines of the great sculptured group at the Paris Exhibition. The center part is designed as a mediæval barge resting in an oval-shaped piece of water ten feet above the level of the main basin, drawn by huge sea-horses disposed near the rim of the basin and spouting foam and water, and ridden by centaurs in various attitudes of urging on the horses. The barge is being propelled on each side by four female figures in a standing position, gracefully pulling large oars with ornamental blades and representing the arts and sciences. At the bow of the barge a figure representing winged Fame with a herald's trumpet announces the approach of the nation, while an allegorical figure of Time, with his scythe tied to the rudder, steers the barge from the rear; above all, in the center, rises Columbia, seated. The figure is, perhaps, not so satisfactory as the rest of the design; it is that of a semi-nude young woman leaning forward with an air of expectancy, with her arms resting on the back of the chair, of semicircular shape. The conception is certainly very fine, and the execution of many of the figures is carried out with a degree of technical skill and feeling worthy of all praise. Of course, French influence naturally predominates; but there is a vigor and a character about the whole which is perhaps not French, and which may be termed American. The whole composition is certainly a fascinating one, and very effective, whether seen in the strong rays of the sunlight or by moonlight, or under the influence of the electric search light. It is of course entirely a sculptor's group, free from the restraint imposed by architectural forms, and is full of movement and vitality, which qualities are further enhanced by the splash and motion of the large volume of water and of the water jets, which send the water in all directions and give life and movement to the whole conception. It is in such a design and for such a purpose that allegory in its noblest and highest form is a legitimate goal to aim at, and there can be no doubt that Mr. MacMonnies has scored a great success.

On either side of this central feature is an electric fountain sixty feet in diameter. At the easternmost end of the grand basin, that is, the nearest to Lake Michigan, and standing on a pedestal thirty feet high, is the colossal statue of the Republic by Mr. Daniel Chester French. It is executed in plaster, and gilded, and represents a woman sixty-five feet high clothed in a Grecian robe. Both arms are lifted; the left holds a staff, upon which is placed a Phrygian cap, the symbol of liberty, while in the right is a globe surmounted by an eagle. The lines of the drapery and the attitude of the figure firmly standing on both feet

is extremely fine, and almost archaic in its simplicity, thus forming a delightful contrast to the Columbian fountain at the other end of the basin, and grouping most satisfactorily with the symmetrical arrangement of the architecture surrounding it. Beyond this, to the eastward, is the peristyle of Corinthian columns of the Jupiter Stator type, running north and south, and connecting the Casino and Music Hall, which face the lake. The columns of this peristyle are arranged four deep, forming three passages, the central one being fifteen feet wide, and the outer ones narrower, the whole conception being founded on Bernini's colonnades in front of St. Peter's at Rome, with the exception that here it is straight on plan. The columns, which are twenty-four in number on each side of the central arch, symbolize the States and Territories of the United States, and the names are carved in the frieze above. In the center is a triumphal arch resembling somewhat that of the Place du Carrousel at Paris. This forms an entrance to the lake from the basin and is crowned by a quadriga representing the Triumph of Columbus, who stands in a chariot drawn by four horses, each pair of which is led by a woman standing between them, and apart from the main group, which faces the Great Court, is a mounted herald blowing a trumpet. The disposition of these figures is novel. Each of the Corinthian columns on either side is crowned by a figure fifteen feet high, representing Eloquence, Music, Navigation, etc., which are continued on the top of the pilasters round the Casino and Music Hall. On either side of the triumphal arch, resting on pedestals on the ground, is a group of statuary representing Navigation and Discovery. The sculpture about this part of the court is somewhat overdone, especially on the peristyle, which has statues on each face, and when seen in perspective the upper part of the statues on the face furthest from the spectator are seen in conjunction with those nearest to him, creating a confused effect. Mr. Atwood himself is dissatisfied with it and contemplates removing the whole of these statues, thus gaining a much quieter effect, and emphasizing the central group.

To return to our plan. To the north of the Administration building are placed the Mines building and the Electricity building, and to the south stands the Machinery building, of a Spanish Renaissance type. Crossing over the bridge, traversing the canal, which runs north and south, we find to the north the great building dedicated to Manufactures and Liberal Arts, inclosing an area of thirty and one-half acres, and on the south the Agricultural building, the whole vista being framed by the peristyle described above, which we may mention was originally designed to be semicircular on plan and to have extended out into the lake, thus forming, we think, a better termination than the one now carried out, but this was abandoned partly on account of the extra expense which would have been entailed in sinking foundations in the lake. The right angle formed by the junction of the building has, however, been softened on each side by the introduction of two circular pavilions, the design being founded on the Temple of Vesta at Tivoli, by Mr. C. B. Atwood. All within the Grand Court has been kept quite formal. Symmetrically disposed are rostral columns surmounted by figures, and around the basin itself and looking into the lagoon are groups of heroic size, representing Agriculture, etc., and also a characteristic series of native American wild animals, modeled by Edward Kemyss and A. P. Proctor, the subjects including grizzly bears, the buffalo, the panther, and the polar bear, etc. These are placed on appropriately designed pedestals at the ends of the bridges. At the south end of the south canal, and forming a finish to it, stands a reproduction of Cleopatra's Needle in Central Park, New York, and beyond is a colonnade of coupled columns resting on a rusticated basement with semicircular arches, and forming an appropriate screen to the stock yards beyond. The center consists of a large semicircular headed opening with heavily coffered soffit and the spandrels filled in with draped figures, which, perhaps, are the most unsatisfactory, being coarse and ill fitting the place they occupy.

All around the great central basin is symmetrical in treatment, but as we proceed along the canal which crosses the Great Court at right angles and runs north and south, the stiffness and formality is gradually left behind till the great central wooded lake is reached. The buildings surrounding this lagoon are placed irregularly, and are therefore more in character with the rustic and picturesque treatment of the landscape. On the western side of this lagoon at its southern end is placed the Transportation building, by Messrs. Adler & Sullivan; it is the most important scheme of exterior color decoration which has perhaps been attempted in modern times, and will be noticed in detail later on. The buildings in the great court were by mutual consent kept white, for purposes of effect, in order not to interfere with the architectural symmetry of this large area, the interiors of the colonnades alone being decorated, but having no restrictions of this kind on the picturesque lagoon.

Messrs. Adler & Sullivan have introduced and carried out in their building a most complete scheme of color decoration, for which the building has from its inception been specially and appropriately designed. It is not an afterthought in this case, but has been the leading *motif* in the design, and runs through and influences the character of every particular feature. Immediately to the north of this is the Choral building, designed by Mr. Whitehouse, of Chicago, polygonal on plan; and still further north on the same side of the lagoon is the Horticultural building, by Messrs. Jenney & Mundie, with its low, glazed dome, expressive of a vast greenhouse.

This, in its turn, is succeeded by the Woman's building, by Miss Sophia Hayden, of Boston. Architectural gallantry is perhaps an unknown quality, but with all deference to the lady architects of America, we think that this building shows that however clever and adept women may become as draughtswomen, they never can become architects, but we will notice the building later on. At the head or northern end of the lagoon stands the Illinois State building, one of the least satisfactory of the State buildings, in a coarse style of Renaissance, and surmounted by a badly proportioned dome. On the east of the lake, and to the north of the Manufactures building, are placed the United States Government building, which is interesting only as an object lesson showing the depths to which *official* architecture can descend, and which it is confidently hoped will sound the death knell of the system in the States. To the northward of the Government building is the Fisheries building, by Henry Ives Cobb, of Chicago, a very satisfactory example of Southern French Romanesque, with symmetrically disposed pavilions.

To the north of the latter, and east of the North Pond, which is connected with the lagoon itself, are the various foreign buildings, including that of Great Britain, to the extreme east on the lake shore front, by Mr. R. W. Edis, in the sixteenth-century manner, with half-timbered upper story, red-tiled roofs, and terra cotta mullioned windows. On the north shore of the North Pond mentioned above is the classically designed Art Palace, by Mr. C. B. Atwood, of Chicago. The main entrance faces north toward the city, and on either side are two wings covered with small domes. The central portion is covered with a well-proportioned dome surmounted by a figure. Filling up the extreme northern portions of the grounds are scattered the various buildings belonging to the States of the Union, and in many cases characteristic of the products and styles prevalent in the States.

Intercommunication between various parts of the grounds is very well organized. The lagoons and basins are well supplied with silent electric launches carrying one swiftly from one part of the grounds to the other, and this is supplemented by an overhead, intramural railroad, running round the outer portion of the grounds, thus keeping the noise away from the buildings themselves. This element of quiet is very important, and the excellently devised waterways are very important in this respect, besides keeping the grounds in a large measure free from dust.

A comparison with the great Paris Exhibition of 1889, however difficult, seems inevitable, and the first which naturally suggests itself is size, and in this connection we find that the site covers an area of 1,087 acres, or nearly six times the size of the Paris Exhibition, while it has five times the amount of space covered under roof, and it is said to have cost $19,500,000, or about five times that of the Paris Exhibition of 1889. These facts, although interesting to the general public are, of course, hardly so to architects, who naturally look to the quality of the designs as their means of gauging the advance or otherwise of architectural taste. The designs of the individual buildings are left for further consideration, but it is to the general scheme that we are now referring.

The buildings throughout are constructed, as to their facades, with wooden frames covered with "staff," a material which has been in use in France (and in England is known as fibrous plaster) for exterior purposes, and which is a fibrous plaster composed of Portland cement, plaster of Paris, and hemp fiber; this is cast into moulds and nailed to laths. It is a material which lends itself readily to the needs of the situation in being comparatively cheap, easy of manipulation, and producing an effect which is all that can be desired for a temporary structure and its sculpture. The style adopted for the buildings on the Great Court is some form of Renaissance, and the architects have kept to a uniform height of 60 feet to the tops of the cornice. The most interesting point, we have said, is the style adopted. At Paris, it will be remembered, the French architects, although steeped in the principles and practice of classic tradition, practically laid it aside for the time, and taking two comparatively new materials, such as iron and terra cotta, gave us a new expression of architecture in boldly allowing their ironwork to show, and filling in behind with the terra cotta to form the face of the wall.

Now we might have expected that the American inventive genius would have developed this idea, and would have carried us still further in this new direction, which architects who have belief in iron as a building material which will give a new phase to our architecture have so long wished to see carried out and exemplified; and one might have expected that the Americans, who do not labor so strongly under tradition as European architects, would have been more easily able to do this. It appears, however, that the great question of cost decided the matter to a large extent, and also the difficulty of getting experienced technical workmen. Paris is a metropolis and has a staff of skilled workmen, while Chicago, although a great Western center, is comparatively young. Extremes often meet, however, and there does not seem to have been any desire on the part of the youngest of nations to develop anything new for its own sake, but rather to show the nations of the world that she can produce something artistic, something, in short, which the older nations would hardly expect her to be able to do; and so it came about that what one would have expected to have seen in Paris came to be carried out at Chicago, and the latter city must be congratulated on having found ready at hand a body of men who by their scholarly work have produced a result which we think without doubt would be a credit to the architects of any country. The lasting effect of the results of their labors will be greater than we can at the present time possibly imagine; but we may safely predict that it will do much for the real progress of architecture and especially of the arts allied to it in America, and it may possibly be a starting point on which the Americans will found an expression of their national aspirations for a higher and nobler phase of architectural art.

The preliminary steps in the procuring of designs for the Exhibition buildings were, of course, watched with great interest by the American architects. To Mr. D. H. Burnham, the Chief of Construction, is due the credit, if any, of having vetoed the obtaining of designs by competition. He, no doubt, with his great practical experience as an architect, saw the difficulties and dangers of such a proceeding, at any rate in a case like the present, where a group of buildings had to be designed in harmony one with the other. Moreover, time was short, the designs had to be prepared simultaneously, and this could only be done in a satisfactory manner by frequent consultation between the architects and the Chief of Construction. No surer and no more ideal way of obtaining these satisfactorily can be imagined than by selecting, in this case, ten architects and forming a council, presided over by the Chief of Construction, whose members could meet in a friendly way and criticise each other's designs to their mutual advantage, and subjugating their own personal feelings to the general advantage of the whole scheme. It is, moreover, a proceeding of no slight importance to English architects that, in a democratic country like America, a blow should have been given to the mania for architectural competitions which is passing through the country at the present time. The position of the buildings and their size having been roughly worked out by Messrs. Burnham and Root (Mr. Root, unfortunately, having since died), and by Mr. F. L. Olmsted, the landscape architect, the designs were apportioned to the different architects, the principal ones on the Great Court to the New York architects, while the buildings further north were given to the Chicago and Western architects.

It was, of course, apparent that symmetry must be observed in the Grand Court of Honor of the Exhibition, and that any display of a romantic or picturesque treatment must be beyond the formal Reception Court of the Exhibition. It was felt that some treatment on classic or Renaissance lines must be adopted, and that with a certain standard of dimensions and modules of proportions, sufficient variety in unity could be obtained to give the whole scheme that personal quality which is so essential in architecture, but which, if uncontrolled, is liable to run in the opposite direction. The buildings are, therefore, planned in relation to each other and on axial lines. A general cornice line of 60 ft. from the ground was then agreed upon as being suitable to the requirements of the case in relation to the court, and further, it was agreed that the module of proportion as to their facades should be a bay not exceeding 25 ft. in width. Beyond this, each architect was left to himself to develop his own design, with the aid of the mutual criticism which occurred at the meetings of the architects.

The selection of the material to be used in the erection of the buildings had, of course, to be carefully considered in every aspect as to appearance, suitability and cost, and also as to salvage at the close of the Exhibition. Various reasons operated in inducing the architects and the Chief of Construction to adopt the use of staff as the material in which to carry out the designs committed to their charge.

Chicago is one of the great centers of the timber trade; timber of all sorts and sizes is shipped there, and it is the cheapest possible building material; it could be used in stock sizes, and this has influenced the designs to a large extent, and when the buildings are pulled down at the end of the Exhibition the salvage will be considerable, and the timbers being used in marketable lengths will render them easily salable. As a covering to this woodwork, staff was eminently a material capable of being manipulated with ease for the purposes of architectural decoration, and of sufficiently durable properties to make it last the period for which the Exhibition buildings would be required. The material, which was used for some of the smaller buildings at the last Paris Exhibition, is composed of one part best Portland cement and five parts plaster of Paris, to which enough long hemp fiber is added to bind it thoroughly together. This is then nailed in blocks with long round nails to the wooden framework, the joints made good with plaster of Paris, and the whole cleaned down. The effect is an effect entirely its own; it resembles white marble a good deal, but is preferable under a strong sun in having no perceptible glitter, while against a dark blue sky or at night with the electric light on it the result is very fine.

The Administration building, by Mr. Hunt, President of the American Institute of Architects, is, from an architectural point of view, probably the most important building on the grounds, in that its purpose is to serve as the grand entrance portal to the Exhibition.* As has been mentioned, it has been placed on the western extremity of the main axis of the Great Court, its transverse axis running north between the Mines and Electricity buildings, etc., through the chief entrance of the Machinery Hall.

On the west is the great Railway Terminus, with its immense hall designed after the Baths of Caracalla at Rome. This station empties the crowds of visitors into the Central Dome, which forms a fitting vestibule to the Exhibition itself. Looking straight in front after entering, through the eastern doorway a view of the great fountains is obtained, and beyond, at the other end of the great basin, 1,100 ft. by 350 ft., stands the statue of the Republic, with the peristyle beyond, with its center crowned with a quadriga, through which is seen the broad expanse of Lake Michigan, which is itself 60 miles across.

From the importance of the position, it thus became necessary to have entrances on each of the four sides of the structure, because of the importance of all of them. The area given to Mr. Hunt was a square of 260 ft., and on this he projected a structure, the center of which is an octagon carried up into an octagonal dome, whose internal diameter is 120 ft., and internal height 220 ft., and external height 275 ft. It will thus be seen that the dome on plan is 12 ft. wider than that of St. Paul's, London, that the height of the interior dome is 20 ft. lower, and that of the exterior about the same as our metropolitan cathedral, not, of course, including the lantern. Round this inner octagon is placed an outer one, about 24 ft. deep, the space between on the diagonal sides being occupied by staircases and lifts, and on the entrance sides by the vestibules and colonnades. On the diagonal sides are four pavilions 84 ft. square, and four stories in height, in which are accommodated the various departments of administration, such as the fire, police, ambulance and foreign departments. These four pavilions are 60 ft. high to the top of the main cornice, which is the height agreed upon by the architects for the main buildings on the Great Court, and this brings the pavilions into relation with the facades around it. The pavilions are inclosed under one Doric order raised on a pedestal, and with an entablature and balustrade above, and are covered with a flat roof; and on each of the three angles is placed a group of statuary, allegorizing the Elements and their capacities, and other subjects.

There is a severity and dignity in the Doric order to these supporting pavilions which contrasts well with the more elaborate Corinthian order adopted in the main buildings on either side. Between these pavilions are recessed the great portals to the dome, one

* We gave an illustration of this building in the *Builder* for August 5, 1893.

on each cardinal face, being flanked with sculpture representing the elements, "Fire," "Water," "Air" and "Earth" on one side of each doorway in its natural, unsubdued state, and on the other in the service of man.

The elevation may be said to be divided into three parts in height—the pavilion story, of which we have just spoken, the colonnade story, and, lastly, the dome. In the colonnade stage, which is about 70 ft. in height, the diagonal corners containing the lifts and staircases are continued and boldly expressed, being taken out square on plan from the diagonal face of the octagon, thus forming a longer space for the Ionic colonnade which occurs between the angles; each of these angle pavilions is covered by a dome, coated with aluminum bronze, supported on the angles with two groups of statuary representing the culminating points of human nature, such as Art and Science, War and Peace, etc.

The third stage in the design, consisting of the dome itself, rises on the inner shell, thus forming an external walking way above the colonnade; it rises vertically for a height of 30 ft., being octagonal on plan, and ornamented with flat pilasters, between which are three panels on each face, on which are inscribed the names of men famous in science, art and industries. Above the cornice which surmounts these pilasters are placed eagles at each of the edges of the octagonal dome; from this point rises the external dome, with three long panels on each face, reaching nearly to the top, the main ribs continuing till a height of 275 ft. is reached. The whole is covered with a glazed skylight 38 ft. in diameter. The panels of the dome are treated in aluminum bronze, as are also those of the smaller angular domes mentioned. The remainder of the exterior has been kept white with the exception of the wall behind the colonnade, which has been painted a red terra-cotta color, which serves as a background for the Ionic columns and emphasizes this part of the design.

Mr. Hunt's building differs from most of the other great structures in having an interior as important as the exterior. Each of the faces of the octagon internally is occupied by a semicircular opening; four of these form the entrances and four open into the space containing the lifts and staircases, with a floor at the level of the springing of the arches. Above is a frieze 27 ft. wide, filled with figures in low relief on each side. These figures are in white on a light blue ground. Surrounding this frieze is a heavily decorated cornice supporting an immense gallery, projecting about 3 ft., above which rises the octagonal drum of the dome itself, ornamented with slightly projecting pilasters; between these at the top are placed latticed windows lighting the interior. The interior dome, introduced as at St. Paul's and elsewhere for the purposes of proportion, starts from the cornice which crowns these pilasters and finishes at a height of 190 ft. from the pavement, with an opening 50 ft. in diameter, which admits the light from the opening in the outer dome. This interior dome is treated with ribs and panels and painted in light blue and gold. The whole of the upper part had to be decorated by the electric light by Mr. W. L. Dodge, because of the scaffolding, and this may have influenced the scheme of color to some extent. In our opinion it is in somewhat too light a key; something bolder and stronger was, perhaps, wanted for such a composition and on such a scale. Through the inner opening the light penetrates from the opening at the summit of the outer dome, which is painted internally by Mr. Dodge with an allegorical group entitled the "Glorification of the Arts and Sciences," consisting of Apollo as a central figure, with a procession extending around the dome representing the arts, sciences and industries. The great drawback of this piece of work is that it is impossible to see it to advantage; only a portion of the composition can be seen at one time, the inner portion being somewhat awkwardly cut off by the inner dome. It is worthy of note that Mr. Hunt had in his mind when designing this dome the great uncovered opening in the Pantheon at Rome, and that he intended to carry out the same idea in his own building, but that questions of utility and climate intervened, and he thought of the great central space in showery weather not being available for use as a shelter, and reluctantly abandoned the idea and glazed the outer surface. The effect, however, of the central lighting remains the same.

There can be no doubt that the composition as a whole is a most effective one, and forms a fitting reception hall to the Exhibition. The idea of having a monumental headquarters does not seem to have occurred to previous projectors of great exhibitions, and it is certainly a new departure. This monumental dome of Mr. Hunt's will bear the same relation to the Chicago Exhibition as Paxton's glass house did to our own 1851 Exhibition, or the Eiffel Tower to the last Paris Exhibition. Granted the fact that an exhibition wants its various departments of management, and you have at once the keynote to the idea, and if they can be placed in a building so designed as to raise it to the dignity of a monument and forming a grand entrance vestibule to the whole Exhibition, it is at once a logical and a proper thing to do.

In this respect the Administration building is a long way ahead of the Eiffel Tower at the last Paris Exhibition, which, besides being ugly and out of scale, was practically useless with the sole exception that it formed a landmark of the Exhibition.

About the sculpture in the building little has been said, it being proposed to treat of this separately in a future article. We must, however, mention that Mr. Karl Bilter, of New York, is the sculptor, and that he has treated it in such a manner as to aid the general effect. The whole scheme consists of twenty-eight groups, the most remarkable of which are the four elements, "Fire," "Water," "Air" and "Earth," allegorized and placed at the four great entrances. On one side is the element in its natural, unsubdued condition, while on the other side it is represented in the service of man and subdued by him. The idea is a novel one, and has been well carried out. It is a curious point, but no illustration yet published has, in our opinion, done justice to this Administration building by Mr. Hunt; in the illustrations, and even in photographs, the building has a hard appearance, which does not belong to it in reality.

To the south of the Administration building, and having a frontage of 840 ft. on the Great Court and 500 ft. to the South Canal, stands Machinery Hall, by Messrs. Peabody & Stearns, of Boston. To give an idea of the extent of the structure, it may be mentioned that in comparison with the Houses of Parliament at Westminster, it stands in the relation of five to two as to superficial area. In designing these great structures the architects had in every case to consider that the form of the structure and the composing materials should be of a marketable nature at the conclusion of the Exhibition. These conditions induced the architects to plan three typical railway sheds 130 ft. wide, placed alongside one another, the naves running east and west, with a height of 100 ft., and supported on trusses 50 ft. apart, center to center. These trusses are built up, the inner and outer members connected with lattice bracing. One point about the ironwork is that it has only been oiled at the works and left in that state, several thousand pounds being thus saved, while the effect is infinitely superior to ordinary painted work, a certain amount of tone being obtained of varying dull reddish brown tint, which is very pleasing. The trusses are connected at the top with a pin connection, and also rest on a steel pier at the base, as the roofs at the Paris Exhibition of 1889.

Crossing these great naves at right angles, and on the axis of the main north entrance, is a transept of the same width, covered by three iron domes of the same diameter, and raised on low drums, and the pendentives filled in with light iron framing. These domes give a justifiable, and indeed necessary, importance to the main nave, from which the others open out on each side, and which, when entered from the main entrance on which it abuts, opens out well in front of one, and prevents any confusion likely to arise from two naves of the same width crossing one another. The interior of the building proper contains no galleries, as in most of the other great buildings, the machines, of course, requiring a good clear height.

In the four angles are circular staircases leading to the galleries, both interior and exterior, formed in the inclosing architectural screen which envelops the internal structure; besides which, on either side of the north and east entrances, are spacious staircases. As has been said, the architects to the Great Court agreed that covered ambulatories should be provided on the ground floor for the purposes of shelter from the great heat of the sun at Chicago in the summer months, and also for a shelter from the heavy showers which come on without much notice during unsettled weather. It was also agreed that for the purpose of general effect and of symmetry the height of the main cornice should be 60 ft. The plan of the Machinery Hall then developed itself. The inclosing screen, 50 ft. wide, encircling the main structure where it crosses at the angles, naturally resulted in pavilions, 50 ft. square, at these points, while in the center of each facade covered porticoes are so designed as to emphasize the main entrances. The facade is laid out on centers which are multiples of the main trusses, placed 50 ft. apart, four divisions occurring to each bay, and consists of a lower rusticated story, forming an ambulatory, and pierced with semicircular arches and rusticated, upon which rests an open colonnade of Corinthian columns, crowned by a cornice and entablature. The treatment reminds one somewhat of Perrault's colonnade at the Louvre, in Paris. The central *motif* in each facade takes up, with the two towers, the width of the nave of 130 ft. wide, which is thus truthfully expressed externally. In order not to form too strong a contrast at the angles, and to bring these pavilions into relation with the screen wall, the Corinthian colonnade is continued round these, being slightly projected in front, and thus gaining a shadow effect. These pavilions are crowned by circular domes raised on a circular drum, pierced with semicircular headed windows, which light the interior glazed dome, the outer dome being crowned with a lantern, bringing the whole height of these up to 130 ft. The angles on plan left by placing a circular dome on the square base are filled up with open campanili of small Corinthian columns supporting a concave roof, these features being richly treated with finials, etc., in the most ornate Spanish Renaissance manner.

The two main entrances are treated in a very bold manner. It seems as if the architects had determined to get contrast at all costs with the elaborately treated main colonnade. All the main horizontal lines are stopped against the perfectly plain face of the lower part of the two towers flanking these entrances, which start boldly up from the ground without any base and perfectly plain for a height of 90 feet, when they are connected across the central entrance with a strongly marked horizontal cornice. Upon these towers are raised very elegantly designed campanili on Spanish Renaissance lines in three gradually diminishing stages on the north front; and in four stages on the east front; those on the north being apparently kept lower, so as not to interfere with the Administration dome. The towers on the east facade contain a very fine peal of bells, whose tone and rendering remind one forcibly of those so well known at Bruges, Ghent, and other Belgian cities, which ring out every day for half an hour or so, and give an air and suitability and appropriateness to the whole conception which is very refreshing, and which, if there had been no *raison d'etre* in their design, and they had only been placed there for architectural effect, would naturally have been wanting.

Each tower is crowned with a winged figure representing Victory. The walls behind the colonnade on the first floor are pierced with windows in two heights, in which Spanish Renaissance dressings are introduced, and figures of infants are largely introduced in the frieze over, holding mechanical tools and bearing festoons of chains of implements instead of the traditional flowers and fruit, etc., and thus bearing out the purposes to which the building is put. The colored decoration to this covered colonnade is in blue and gold, and the capitals of the Corinthian columns are picked out in gold leaf along the whole facade.

The semicircular roofs to the great trusses express themselves rising on the inner walls of the colonnade, and are seen from a distance best, being 50 feet back from the face, and above these, where they occur on the plan, are seen the three domes over the great transept treated simply with a circular drum with louvers for ventilation, and crowned with winged figures.

Returning to the central porticoes, the least satisfactory point is, perhaps, the *appliqué* appearance which the two porches have, the circular one 95 feet deep and 75 feet wide, and with Corinthian order 60 feet high, opposite the Administration building and the square projection porch on the east front. The whole design gains much from the sculptor's art. Mr. A. Waagen has been intrusted with this. Over the semicircular portico he has placed six figures bearing portraits of prominent inventors. Above these and resting on pedestals supported by the great cornice connecting the two towers are five figures 13 feet high, the center one representing Science, and those on either side "Fire," "Water," "Air," and "Earth," the two towers being crowned with a figure of Victory.

The pediment in the eastern entrance represents "Columbia" seated on a throne, to the right and left are inventors of machinery, while the lower corners are filled in with lions, representing brute force subdued by human genius, represented by two children.

Messrs. Peabody & Stearns have certainly produced a work which, although designed on strictly classical lines, possesses enough variety in its general features to give it sufficient interest, especially as the architects have adopted the architecture of the land of Columbus as the fountain head from which many of the ornamental features have been borrowed.

The Agricultural Hall, by Messrs. McKim, Mead & White, occupies the larger part of the south side of the great basin to the Court of Honor, and is bounded on the west by the southern portion of the Lagoon, which runs south from the great basin, and on the east by the shore of Lake Michigan itself. The building covers a space of 800 feet long by 500 feet deep, being practically the same size as the Machinery Hall, which faces it on the west.

There is, besides the main building, an annex on the southern side of 550 feet by 300 feet. The main building consists primarily of two central naves 95 feet wide, crossing one another at right angles on the longer and shorter axis of the building. These are roofed with trusses of very light construction, in this respect differing from the well-designed trusses of the Machinery Hall opposite, which, it will be remembered, were built so that they could be sold for railway stations at the end of the Exhibition. The construction of the roofs to the Agricultural building is a composite one, wood entering largely into the design; the height of the central nave is 75 feet, and the lantern which runs from end to end of these naves is made entirely of wood.

On each facade is a covered ambulatory as agreed upon by the architects. Each of the great naves mentioned is accompanied on each side by two-storied aisles, kept sufficiently low to allow of a clearstory being formed in the upright portions of the great naves. Running longitudinally east and west on each side of the aisle to the great nave are planned three further aisles of lower height, arranged with skylights, and two stories in height, the first floor of the center one being, however, left out for the admission of light to the ground floor, while the roof of this center aisle is taken higher for the purpose of forming a clearstory. On the outer faces to the facades are formed galleries on the upper floor, the lower portion being treated as a covered colonnade as mentioned. On the east and west sides the galleries on the first floor are about 50 feet wide, while on the north and south they are only 23 feet. This was necessitated by the placing of the main or north facade, and is expressed truthfully on each face of the building.

On the center of the main front facing on the great basin, and emphasizing the main nave, running north and south, is placed a dome, 78 feet in diameter and 130 feet high, surrounded internally on the ground floor with Corinthian columns of the same height as the main external order and placed in pairs. The dome is coffered internally. The aisles on either side of this nave are accentuated on the facade by masses which form solid wings to the portico which is placed between them. Where the surrounding galleries meet they naturally form corner pavilions, which are differently treated on each face, in order to properly express the plan, and are crowned with low, square, pyramidal-stepped domes, crowned with a group of four women, representing the four continents of the world, supporting a globe. The *motif* of the facade consists of a Corinthian order of 50 feet high, without pedestals, supporting an entablature 10 feet high. The central pavilion on the north front has eight pilasters, the four central ones having Corinthian columns in front, which are carried up with a small attic with figures, and crowned with a pediment. To each of the end pavilions of the same front are four pilasters, figures also occurring above the main cornice and below the square pyramidal dome. The space or curtain wall between these main features on either side is further divided up by two massive piers, consisting of two pilasters with a doorway in the center on the ground floor, and which serves not only to prevent monotony in the facade, but also answers the purpose of emphasizing these doorways. The main cornice breaks around these projections; above are placed groups of statuary, representing Agriculture in various phases of bucolic labor. Thus the architects appear to have marked the entrances to the structure in a manner befitting their importance; the central or more important one with eight pilasters, the four central ones having columns in front with pediment over, the end doorways with four pilasters, the pavilion being crowned with a dome, and the intermediate or minor entrances, two to each curtain wall, with coupled pilasters to a projecting pier, and crowned with a group of statuary, while the full-sized order occurring at well-defined points serves to keep the design well knit together. The space between these piers is again further subdivided into three bays, the lower portions of smaller Corinthian columns, supporting the gallery on the first floor and carrying an entablature at the gallery level, at which point they are connected with semicircular arches, divided by figures representing the signs of the zodiac, and supported on projecting Corinthian columns. The spaces between these columns are again subdivided into three by columns of the same order, which express on the facade the spacing of the wooden columns used internally to support the floors.

The facades to the lake and to the small lagoon develop themselves from the plan, the angle pavilions being emphasized and treated with projecting porticoes.

crowned with a tympanum filled with sculpture, and on each side buttressed, as it were, with flanking piers, and crowned with the low, pyramidal domes which show, of course, on the main front with the four female figures holding aloft the globe. These porches express on the facade the open aisle extending behind of a width of about 48 feet, the blocked-up portion or flanking piers representing the line of the columns supporting the gallery floors. The central pavilion to these fronts does not project, but is so grouped with the piers on either side as to emphasize the great nave going east and west. These piers are treated the same as on the main front, and are crowned with statuary, while the curtain walls on either side consist only of a three-arched bay split up again into three divisions as before.

The roofs, which are of low pitch and crowned with slight pitch, are seen above the main cornice. The Agricultural building is by far the richest of the buildings which face the Great Court; not even, we think, excepting the Administration building itself. It seems, in fact, designed from its commencement for a profuse treatment in sculpture, and it is doubtful which holds the greater prominence in the composition, the sculpture or architecture proper. The sculpture proposed has been carried out by Mr. Philip Martiny, of Philadelphia, and has been conceived by him in a very bold spirit, perhaps allowable, and even justifiable by the gigantic order employed throughout the design. Each group represents some agricultural subject. Besides the four corner pavilions already mentioned, Mr. Martiny has produced a group of horses led by two laborers and drawing a chariot in which stands a figure representing Agriculture, and also a group of oxen led by a figure and drawing the ancient beam plow of Virgil. These two groups, which are duplicated on the facades, are placed over the piers containing the intermediate doorways, and are executed with much vigor. The groups in the four pediments to the porticoes at the ends of the smaller facades, which represent Agriculture, the women holding the signs of the zodiac over the smaller Corinthian columns, and two groups of the Four Seasons were also executed by Mr. Martiny, while Mr. L. J. Mead, of Florence, has executed the central pediment representing Ceres, the Goddess of Agriculture. The dome over the central entrance is crowned by a gilded figure of Diana, 18 feet high, which formerly stood on the Madison Square Tower, New York. The right foot of the statue rests on a small ball, which turns with the wind.

The color decoration will be more specially noted later; it has been executed by Mr. G. W. Maynard, a painter of note in the States, and is in the Pompeian style. The central portico and the four end porticoes to the minor facades are the points at which color is applied, and it serves its purpose of accentuating the design at these points where it is needed, besides being under cover, and therefore protected from the elements. The whole scheme is treated with rather strong coloring, and is composed of figures singly and in groups, relating to agricultural traditions. From these remarks it will be understood that the Agricultural building is very rich in its general effect, so much so as almost to be called sumptuous; it might even be said by some that too much sculpture had been used if it were for a permanent building, but for a temporary structure we think it errs, if at all, on the right side. Being designed with its colossal order, and being emphasized also by bold masses of plain masonry, it carries the sculpture applied to it, and with a certain sense of contrast, which is very pleasing.

The proportions of the whole are good, and the general setting out of the elevation, so as to emphasize certain features in the plan, seems very well thought out. The broad terrace in front and the broad flight of steps leading down to the main basin also help to bind the whole design, so as to make it form part of the whole scheme, and to cause it to pile up gracefully from the water's edge, which serves as a base to the composition. It is in general effect more sedate than the Spanish treatment of the Machinery Hall, which faces it across the smaller lake, and must add largely to the reputation of the architects, Messrs. McKim, Mead & White, of New York, who already hold such a high reputation among our professional brethren in the United States.

(To be continued.)

THE CHICAGO EXPOSITION.

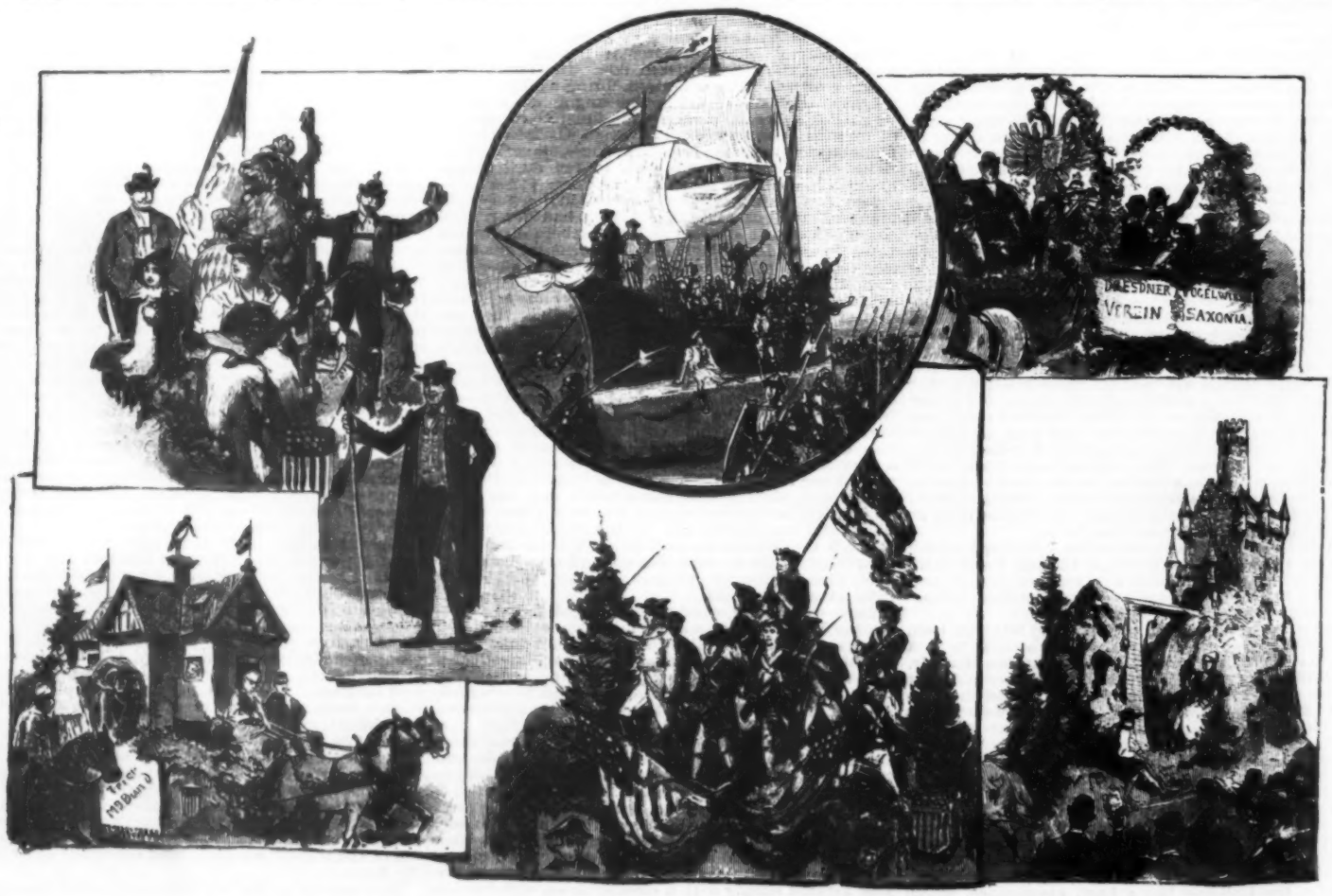
GERMAN DAY.

THE seeds that were sown under the encouragement of the Emperor and the liberality of the Reichstag, by the energy and enthusiasm of those engaged in the arts and industries, of merchants and scientists, and by the circumspection of officials, will yield a bountiful harvest. Our exhibitors are sure of numerous medals and diplomas; a tribute to the German people from representatives of all parts of the world, but especially welcome and pleasing to us are the congratulations of the German-Americans, the expression of brotherly love. Never before the Exposition did we so fully realize that Germany has spread over two worlds, that the German heart beats also on the other side of the wide Atlantic. Our exhibits at Philadelphia in 1876 were not such as to excite the enthusiasm of Germans in America; but then our German empire was only five years old. Now, it has attained its youth and has developed its full strength. The German "Michel" is no idle dreamer, but a giant who can accomplish heroic deeds. What he has accomplished in Chicago has filled Columbia's Germans with astonishment and pride, and they have become conscious of the fact that they too are Germans, in their heart of hearts. In order to give expression to this feeling they appointed the "German Day," a triumphal fete for German genius, a day of rejoicing and honor for all Germans wherever they might be. June 15 was the day decided on, and Germans hastened to Chicago from all parts of the great American West and from the large cities of the East. The German minister, Baron Von Holleben, was present as a mark of respect to the American nation and to President Cleveland, and the German-Americans called their great countryman, Carl Schurz, the old forty-eighter, whose German blood would not allow him to remain quiet, although he was ill in New York. He came and delivered a speech that warmed the hearts of Germans on both sides of the ocean. The German commissioner also spoke. What a beautiful picture! Our black, white and red flag fluttered beside the star-spangled banner, and the girls and women of the chorus wore dresses of black, white and red, forming a living national emblem. This scene in front of the German house betokened the brotherhood of all Germans, uniting those who belong to the land that stretches from the North Sea to the Alps, from the banks of the Rhine to the Memel, with those whose lives are separated from Germany by thousands of miles and by centuries, but have yet remained good Germans. In the name of the latter Harry Rubens, of Chicago, offered a greeting to the German guests, and a chorus of 2,000 male and female voices sang "Deutschland uber alles" and "Das treue deutsche Herz." They were accompanied by the Bulow orchestra and led by Prof. Katzenberger. Besides this greeting of German America to Germany an English meeting was held in Music Hall, by the presidents of the local and national boards, Higinbotham and Palmer.

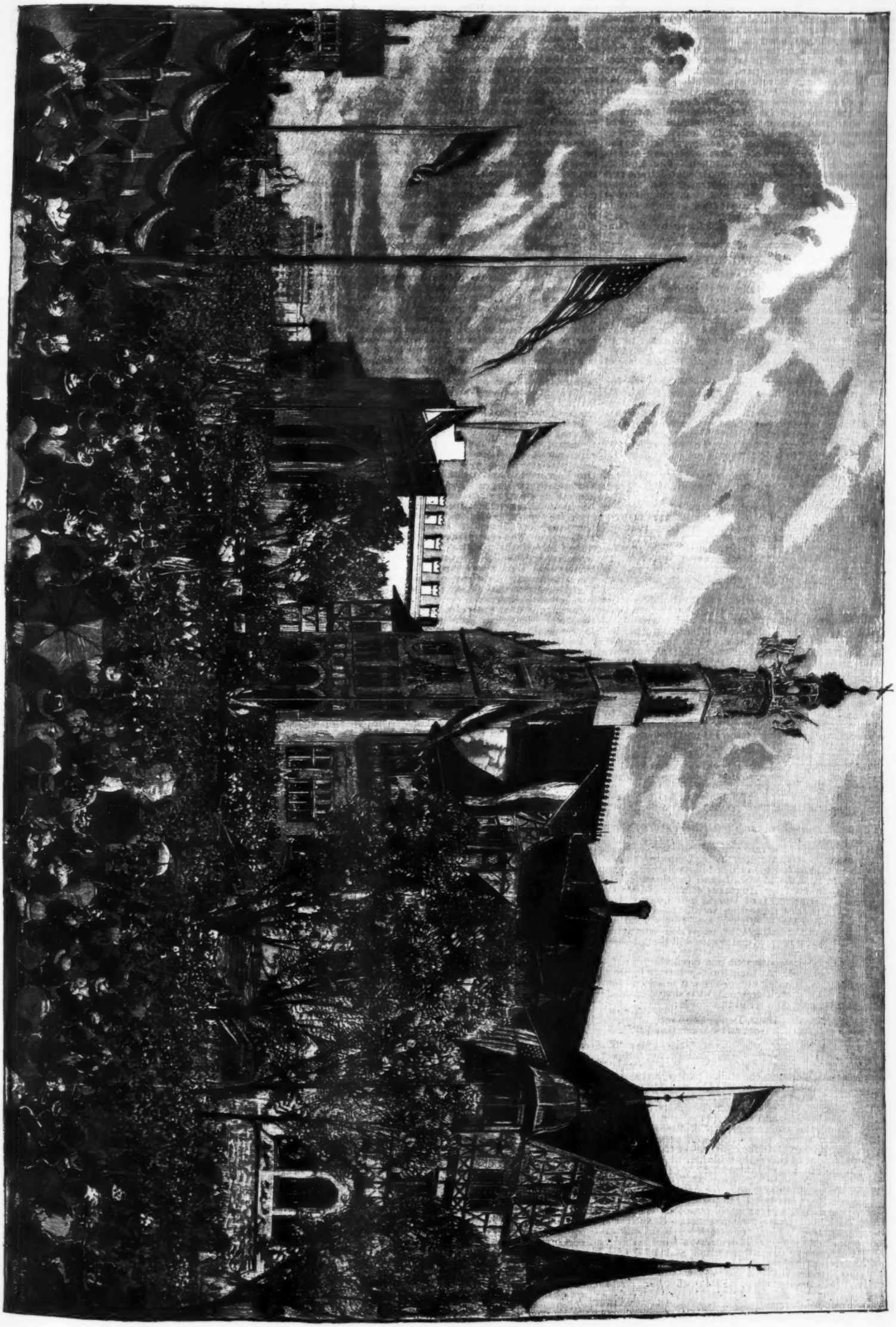
Austria, Sweden, Japan, Switzerland and England expressed their friendliness by raising flags on their buildings, and Spain sent the band of the 12th Infantry Regiment of Saragosa to the German House.

At noon 193,000 people came to the Fair, after having assisted at a long parade in the center of the city.

GERMAN DAY IN CHICAGO—THE PEOPLE WATCHING THE PROCESSION ON MICHIGAN AVENUE.



GERMAN DAY IN CHICAGO—GROUPS FROM THE PROCESSION.



GERMAN DAY IN CHICAGO—THE CELEBRATION IN FRONT OF THE GERMAN HOUSE.

When the rising sun tinted the eastern heavens, the streets were alive with men in festive garb; 25,000 members of the Turnverein, Schutzenverein, singing societies, veterans' associations, lodges, etc., turned out to take part in the festival. In the procession were many floats carrying allegorical pictures representing events in the history of Germany and in the history of America, in which the Germans have taken such an active part, including the war of 1870, the American Revolution, the German Revolution, Germantown in Pennsylvania, German art and industry, etc. These wagons and the carriages carrying the uniformed officials of the German department of the Exposition passed through interminable lines of spectators. It was really a German festival.

The city of Chicago sent its representative, the gray-haired mayor, who assured the German-Americans that the city owed them much. The English press appeared with titles in large German letters, and the German papers published illustrated extra sheets. The German Day was a harvest day, we gathered glory and honor, and even the material results of our brilliant exhibit were not lacking.

Drawings made for *Illustrirte Zeitung* by E. Limmer.

GERMANY AT THE WORLD'S COLUMBIAN EXPOSITION.

THE government buildings of the three European nations with which our relations are closest stand near together on the lake front in Jackson Park. Victoria House is built like an elegant modern home in London. France's building is modeled after the Petite Trianon. Das Deutsche Haus, most beautiful of all and the most picturesque structure on the Fair grounds, is in the style of the German Renaissance of four centuries ago.

Unlike the other structures of the White City, the German House is built largely of iron and stone. Its front is 135 ft. and its depth 160 ft. The main tower rises to the height of 180 ft. The exterior walls are adorned with sgraffito paintings by Max Seliger. High above the main entrance is the imperial black eagle; below it are the coats of arms of the German states; while to the right in bold letters is an ancient motto, which is thus translated:

"Fruitful and powerful, full of corn and wine, full of strength and iron, tuneful and thoughtful—I will praise thee, Fatherland mine."

On the north side is a large painting of St. George and the dragon. High gables, balconies, turrets, oddly shaped windows and the irregular tiled roof, all contribute to the picturesque effect.

The interior is in three distinct parts: The portion devoted to the offices of the commission, which is divided into two stories; the broad square hall and reception rotunda; and the chapel, which are all two stories high.

The first thought of the visitor in the building must be: "The Germans are a reading people!" On a table in the rotunda are files of newspapers of recent dates from Berlin, Dresden, Cologne, Hamburg and other important cities, and the chairs invite to their perusal. Just beyond in the square hall the book and picture dealers from these cities have their large exhibits of richly bound books—the German classics and their popular writers of to-day and translations of the choicest French and English literature. There are superb portfolios of reproductions of the masters in painting. Perhaps the finest exhibit is made by Ernst Wasmuth, architectural book dealer in Berlin. He shows books treating of ancient and modern architecture, with most elegant illustrations. The space above them is adorned with pictures of the exteriors of notable buildings in black and white, and colored reproductions of arches, windows, columns—rich and rare bits gathered from many sources.

The well known Tauchnitz house in Leipsic has a large space filled with their books bound uniformly in brown.

The music and school-book publishers are well represented.

As illustrative of the rare and valuable books shown, I may mention one exhibited by a Frankfort house. It is an edition in fourteen thick folio volumes of the Flora of Brazil, a Latin work begun by Carolus Martius and completed by Augustus Eichler under the auspices of Ferdinand I. of Austria and Ludwig I. of Bavaria. The only protection to all these treasures is the absence of seats. Visitors may freely read any books and look at photographs, maps and engravings as long as their powers of endurance will permit them to stand.

From this book department one descends by a few steps to the chapel. At their top is a bronze figure of the Saviour, with hands outspread as if in benediction. Above is a lofty arch frescoed with emblematic designs and bearing on a scroll the words:

"Deutsches Haus, Deutsches Land,
Schutz dich Gott mit starker Hand!"

The chapel has large windows of colored glass. The central one, representing Christ stilling the tempest, made by Mayer & Co., of Munich and New York, is to be ultimately placed in the chapel of the Naval Academy at Annapolis, in memory of the men from that institution who died at Samoa in the hurricane in 1889.

The floor of the chapel contains cases filled with ecclesiastical vessels and vestments of rich workmanship. Along the walls are groups of figures in wood representing sacred personages and scenes, such as adorn the Roman Catholic churches of the Continent.

Stepping out of this main building, at the side one finds himself in a most interesting annex to it—the exhibit of the Sulphite Company at Waldhof on the Rhine, where cellulose is manufactured.

In room No. 1 is a large photograph of the works. Before the door is a great pile of pine logs stripped of their bark and ready for conversion. Heaped upon them are masses of coal, pyrite, iron, limestone and zinc (obtained by electrical deposition from spent pyrite), representing the raw materials and by-products of the process.

In large glass jars in a case along the wall is wood in small bits, ready to be boiled; other jars contain pulp in various stages of bleaching in the form of sheets, and ready for nitration to be used for smokeless powder. Below, are writing paper and envelopes of fine quality made of the pulp. On the walls are glass cases containing white lace, a tourist's shirt, colored twine in balls, and a fabric for furniture covering of dark colors and oriental-looking designs, all made from the pine fiber by the "Tuerck" patent process.

The daily production of the works is 120 tons of cellulose.

Not the least interesting part of the exhibit are the by-products arranged in tall jars under the picture of the works. They are (1) oxide of iron, (2) zinc, (3) spent pyrites, (4) ethyl alcohol, (5) spent sulphite liquor obtained by evaporation, (6) sulphite of lime, (7) artificial charcoal (from spent sulphite liquor) (8) the wood pulp prepared for the manufacture of collodion.

In a small adjoining room are beautiful photographs of the pine forests in their native condition, and in process of destruction by man. There are also specimens of all the various insects in their larval and later stages, which injure the tree.

A room on the other side of the main one has immense sheets of paper, from the finest letter paper to the heaviest wrapping paper, arranged with a strong light behind them to show their quality.

One large sheet suspended from a frame has iron weights to the amount of 440 kilos. attached, to show its "breaking strength." Wrapping paper hung in the same way shows a "breaking strength" of 810 kilos.

The official catalogue of the German exhibits at the Fair is a closely printed volume of more than 300 pages, and in a review of them like this, it is possible to write only of the very conspicuous ones and of those which offer most instruction to us Americans.

In the Agricultural building, sugar making from the beet root is fully illustrated. It is interesting to note that purification of the sugar by use of animal charcoal is almost abandoned. The juice is first clarified by adding lime, three per cent. of the weight of the roots being used; the excess of lime is precipitated by carbon dioxide generated in the lime kilns; the juice is further purified by a second saturation with the same gas, and lastly by sulphurous acid.

In the building devoted to Manufactures and the Liberal Arts Germany occupies large space: in the former department nearly a thousand exhibitors are represented, and in the latter the government has placed specimens of educational work, from the universities and technical schools down to the kindergartens. The pavilion on the lower floor is in a central location, and its main entrance on Columbia Avenue is through the fine iron gates, which to some eyes are themselves the most beautiful exhibit which Germany contributes to this building. There are three gates. The central and highest is not less than 30 feet high in the middle. They are all elaborately wrought by hand. No tools except hammer and chisel were used upon them. They were made by the Armbruester Brothers, of Frankfort-on-the-Main. Light and graceful in detail, the effect of the whole is of a massive barrier.

Directly beyond the gates are a large fountain and the great allegorical painting on tiles from the Berlin Porcelain Works.

Passing within the one open gateway to the left, one comes upon a bronze copy of the famous statue of Frederick the Great on Unter den Linden. Another set of iron gates guard the treasures which have been sent to the Exposition by members of the German royal family and other persons of rank. These consist of magnificent cases in which letters have been presented to Bismarck and Von Moltke by different cities and organizations in recognition of their services; of the rich gift of the city of London to the young Emperor, and of wedding gifts to various Hohenzollerns. They may well be proud to send these costly presents across to our sometime disturbed republic, if they do, indeed, represent the loyalty and affection of the nation.

There are several rooms containing the best that German furniture makers can show. Those exciting most wonder are the model of the famous throne room of King Ludwig, of Bavaria, in Munich, and a reception room from which it opens. This is spacious and in the style of the German Renaissance of the sixteenth century. The doorways and mantels are formed of beautiful mosaics; the chairs, cabinets and bronzes are all dark, rich and ancient, and will give an air of princely splendor to the American home in which they are placed, if the exhibitors are fortunate enough to sell them.

Most tempting objects in Dresden china and carved ivory are close at hand.

But it is in Germany's remarkable chemical exhibits that the readers of the SCIENTIFIC AMERICAN will be more interested. Approaching the building from the charming Wooded Island, and entering by the west side doorway, one comes at once to the ultramarine grotto which is at the portal of the chemical department. Great blue stalactites depend from the roof of the cave, while a sphinx in gray rock, symbolizing the secret of the manufacture of ultramarine from inorganic matter, guards the entrance. The exhibit is shown by the associated ultramarine factories, whose offices are at Nurnberg, and whose works are there, at Linden near Hanover, at Auderach and in other small places.

For raw materials, they use alumina, silica, soda, sodium sulphate, sulphur, resin and charcoal, and make ultramarine in blue, green, red and violet shades, exporting much of their product.

The other exhibitors have been content to place their work in cases of wood with glass fronts. Much taste is shown in the arrangement of the exhibits. An apprentice is never taken in a German chemical factory; a man must have had scientific training to find a place there; the harmonies in color and effective grouping of elements and their infinite compounds in these cases suggest that the German chemist must be also an artist.

The acid and alkali industry is largely represented. In 1891 the country produced 627,292 tons of sulphuric acid; more than half of this was made from pyrites from the Rio Tinto mines in Spain, which yield enough residual copper to pay the cost of transportation to the Rhine provinces. The Actiengeselischaft fur Chemische Industrie in Mannheim, whose factories are at Rheinau (Baden) and Barmen, make a specialty of liquefied gases—carbonic acid, ammonia and sulphurous. The last is put up in wrought iron bottles. Liquid chlorine is a novelty put up in steel cylinders.

Another Mannheim company which controls four soda factories produces soda at the one in Heilbronn, by an ammonia process which differs somewhat from Solvay's. At the other works, the Leblanc process is still used. The output of soda from these factories is the largest in Germany, except that of Solvay's own firm. This exhibit includes besides the compounds of soda, chloroform, hydrate and sulphate of alumina, magnesia carbonate, sulphate of iron, nitric and sulphuric acids.

The chemical works at Griesheim and Kuppersteg demand considerable attention. At the former factory, after five years of experiment, chlorine and the alkaline metals with which it is found in union have been successfully separated by electrolysis, and on a scale to be commercially valuable.

This firm manufactures 100 per cent. sulphuric acid by freezing the common English acid.

Their exhibits are arranged in jars connected by chains in such a way as to show the genetic relation between the raw, intermediate, auxiliary and final products. For instance, from a kilo of pyrites with the following other crude materials, nitrate of soda, rocksalt, limestone, coal, chrome ore, potassium chloride, there may be obtained of by and auxiliary products: Niter cake, salt cake, nitric acid, 40° Bé., purple ore, black ash, nitrate of soda, burned limestone, muriatic acid, 20° Bé., fused chrome charge, sodium sulphate, sulphuric acid, 66° Bé., chloride of sodium. Final products: Nitric acid, 48° Bé., sulphuric acid, 99·7 per cent., muriatic acid, 20° Bé., sulphur, caustic soda, 128 per cent., sal soda, soda ash, bichromate of sodium, bichromate of potassium.

One of the most beautiful exhibits is that of the Arsenic Mining and Metallurgical Works in Reichenstein, Silesia, called "Reicher Trost." "This is the most important establishment of its kind in the world and can boast of a very old and remarkable history." It was worked as a gold mine for hundreds of years. The production of arsenic was begun in 1699.

The firm exhibits: Crude ore from the "Reicher Trost" mine, washed arsenical pyrites, white sublimated arsenic powder, yellow and red arsenic in lump and in powder, gray metallic arsenic in crystalline lumps and powder, and an octahedron of gold representing the gold in a ton of residues.

Th. Goldschmidt in Essen-on-the Ruhr is the name of a factory started in Berlin to supply dye houses with metallic mordants and starch preparations. The works now carried on at Essen manufacture the tin and zinc salts and show, besides these, the stannate and phosphate of soda, chlorides of manganese and phosphorus. The samples of cotton goods, velvet and skeins of silk illustrate the uses made of these products. The exhibit includes railway sleepers which have been treated with zinc chloride and have been in use from ten to twenty-six years.

Perhaps there is no more important exhibit than that of Dr. F. Von Heyden Nachfolger, at Radebeul, near Dresden. The factory at first produced only salicylic acid and its salts; but in the large laboratory connected with it most valuable discoveries have been made. There Dr. Seifert found the remedies or disinfectants (as the case may be) solutol, solveol, guiacol and creosote carbonate. Solveol is equal in its disinfecting properties to carbolic acid, less caustic and one tenth as poisonous. Guiacol (or guayacol) carbonate is a new toxic preparation of guiacol (or guayacol) introduced in 1890 and found to be the best known remedy for tuberculosis. According to Drs. Seifert and Holscher in *Berlin klin. Wochenschrift* (1891, Nr. 51, 1892, Nr. 3), "Guiacol carbonate removes steadily and permanently from the blood of phthisical patients the poisonous substances generated by tubercle bacilli. Visible results are cessation of cough and expectoration, and disappearance of fever and night sweats." An important branch of the business is the manufacture of aromatic oxycarbonic acids, in which carbon dioxide under pressure reacts upon the alkaline salts of the phenols.

The salols, salicylic ethers of the phenols, used as medicines, are shown as white powder and translucent crystals; sucrol, a new sweetening agent, is in acicular crystals. The firm of Rudolph Koepp & Co. has a rare exhibit. It was the first establishment in Germany to make oxalic acid and oxalates from sawdust. It has now a branch factory for the exclusive manufacture of hydrofluoric acid. It has given to the dyeing industry fluoride of chromium, double fluoride of antimony and antimony salt. The exhibit includes the oxalates and fluorides of antimony, sodium and ammonium.

The firm of E. Merck, at Darmstadt, has a comparatively small exhibit in this building, but has a house of its own near one of the principal entrances to the grounds. Begun in an apothecary shop in 1668, the business has never passed out of the hands of the Merck family, and has grown to great proportions. They were the first to make aconitine, atropine, digitaline and caffeine in a pure state. As long ago as 1862, they began to prepare cocaine.

The largest chemical factory in the world is that of the Badische Aniline and Soda Works, at Ludwigshafen-on-the-Rhine. There are branch establishments at Neuville-sur-Saone, in France, and at Butirki, near Moscow, Russia. The exhibit is worthy of the firm.

It is placed in large cases, and includes the full range of aniline and alizarine colors, with wool and silk fabrics of great variety dyed in them, and a picture of the works at Ludwigshafen. In these alone 4,000 workmen are employed and 78 chemists. It was there that the synthetical production of alizarine was begun in 1868. This was followed by the manufacture of alizarine, anthrapurpurine and flavopurpurine from the sulphonates of anthraquinone. Later years have brought out the resorcine dyes, methylene blue, the acid magentas, violet and the greens, the azo dyes and others of no less importance, with their almost endless scale of derivatives.

As demonstrative of the superiority of the artificial alazarine blue, cloth suitable for men's clothing is shown dyed with this and with vegetable colors. The large samples of both kinds have been exposed on roofs of houses in Florida and Mississippi for 52 days; that dyed with the vegetable color is faded to a muddy gray, while the artificial blue is unchanged.

In closing this account of the chemical industry of

Germany as indicated by the exhibits at the Fair, it is but just to refer to the remarkable provision for the well-being of work people made by all the firms mentioned and by others of prominence, unnoticed here for lack of space. Houses are provided at low rental; baths, hospitals, relief funds, pensions, etc., are very generally furnished by these establishments. The daily wages are, in cases stated, between two and three marks.

In the Mining building Germany's exhibits make good her claim to the first place in the mining industry of the European continent.

The display of the United Iron Works of the Stumm Brothers, of Neuenkirchen, and Rud. Boekling & Co., at Halbergerhutte, is best described by the German word *grossartig*.

The entrance to the wide inclosure it occupies is through a high and massive portal formed of iron tubing. It is surmounted by a bronze figure of a man with immense bronze winged dragons on each side of him.

Beyond this is a beautiful fountain, formed of tubing of differing sizes and adorned with bronze figures in positions illustrative of work in iron. At the outer boundaries of the space stand two obelisks formed of castings, 45 feet high. Near these are two graceful structures, much higher, reaching to the roof of the building, formed of tubing of many sizes and designed for many purposes. Besides these objects, there are masses of iron and steel castings arranged in other forms; models of a rolling mill, and single pieces of apparatus used in one; models of the foundry at Halbergerhutte, and of dwellings, restaurants, bath houses and hospitals for the employes at Neuenkirchen. The background of this wonderful exhibit is a lofty, broad surface, apparently of masonry covered with mosaic; it is actually covered with the products of the slag-cement factory of the Erhardt Brothers, in Neuenkirchen. Upon this are tables of statistics about the works: 4,300 workmen employed; 60 puddling ovens and 194 steam engines of 25,000 horse power in use, etc.

A beautiful and unique exhibit is that made by the German Gold and Silver Refinery, whose headquarters are at Frankfort-on-the-Main. At the back of the booth is a fresco representing a pleasing landscape. It is composed of the bay of Puerto de Mazzaron, in Spain, where the silver and lead of the company are mined, and of the works there; of the offices of administration in Frankfort; of the chemical works among the hills where they manufacture sulphate of quinine; and of the half wooded mountains which stretch beyond. The landscape has a soft light thrown upon it and is a most effective background. In the cases in front are retorted silver, gold in bullion, and masses of beautiful artificial crystals. In the side cases are a variety of mineral colors produced at the works and specimens of ceramics on which they have been used.

Near this booth is the display of agates, polished and worked into bowls. One of these mounted on silver is valued at $1,000. The clock said to be made of the largest agate in the works is curious, but not beautiful.

In the gallery is shown a great quantity of apparatus used in the mines, especially in coal mines; of these some interesting models are exhibited, notably that of the Koenig and the Koenigin Louise mines at Zabize in Oberschlesien. The maps of Prussia and the Thuringian States made by the Imperial Geological Survey are full and very fine. So are the maps found in portfolios made at Bonn University.

A simple device for separating iron from other elements by shaking up a solution which is mixed with ether and permits the fluids to arrange themselves according to their specific gravities is interesting.

Most important to the scientific world is the statement made on a card placed near the model of apparatus for sinking shafts—the statement that the deep well boring at Paruschowitz, carried on by the Koebrich apparatus to the depth of 6,573 feet, has been stopped to find the temperature of the earth, and is to be continued as far as the appliances will permit.

In the Electricity building Germany shows cases of optical instruments, telescopes, microscopes, etc., for which the makers are famous. Besides these there is much of interest to electricians. A collective exhibit of the historical development of electricity in Germany includes the magnet induction needle telegraph of Stohrer, 1817, and the Gauss Weber apparatus of 1830. Siemens & Halske, whose works are in Berlin, Charlottenburg, Chicago, St. Petersburg and Vienna, show three-phase motors and transformers. A step-down transformer for inside use and a step-up for outside use are both of 50,000 watts capacity, and in both air alone is used for insulation.

A three-phase motor of 60 horse power is displayed which has a starting arrangement consisting of a ring fastened to the armature shaft and revolving with the armature; by means of conical bearings and screwing in or out, this breaks the armature circuits or throws them together. A three-phase motor is also adjusted on a street railway truck; it has external fields, but is dust and weather proof. This motor has a capacity of 30 horse power when the star connection is made for the three wires; it has three times this power when the triangular connection is made. A worm gear is used to attach it to one axle, and it is designed for 600 volt circuits.

A bronze bust of Siemens on a high mounting, with a large wreath of oak leaves in bronze at the base, indicates the honor in which this inventor is held.

Three-phase motors are also exhibited by the Allgemeine Elektricitat's Gesellschaft. It was this firm which made the plant for the celebrated Lauffen experiment when about 3,000 horse power was transmitted by electricity at 30,000 volts from the Falls of the Neckar, at Lauffen, to the Frankfort Exposition. The motors here shown are better than those used in that experiment. Electrical clocks, which may be placed in a common lamp circuit and set automatically to the right time from the central station by lowering the electro-motive force of the generators, are shown. This company has other very interesting apparatus, some of which offer novel features and deserve close study. The display of wire goods, adapted to a great variety of purposes, of Felton & Guilleaume, of Muhlheim, the fine pavilion of the Frankfort firm of Hartmann & Braun, containing electrical measuring instruments, and several other exhibits, all contribute much to the interest of the new domain which the Electrical building forms.

In Machinery Hall Siemens & Halske have a 1,000 horse power engine running one of their great dynamos of 500 volts. It furnishes part of the electricity used in lighting this and the Electricity building.

G. Polysius, of Dessau, has a large display of machinery, including engines, crushing machines, etc. Seck Brothers, of Dresden, show a middlings purifier built of wood, with a row of glass doors along the middle through which the process may be watched. Beside this, G. Luther, of Braunschweig, exhibits a bolting machine for all kinds of flour.

Of special interest to bakers is the dough-dividing machine shown by H. Bertram, of Halle-on-Saale. It is for the purpose of dividing dough in weight, according to the current prices of flour. It is easily portable, can be placed on the trough and avoids all waste of flour.

The exhibit of the Krupp Works, at Magdeburg-Buckau, comprises most ponderous machinery, adapted to the manufacture of the guns and other implements of war for which the name of Krupp is famous. A chill mill, for instance, has two rollers, each of which weighs 12,000 pounds. A rock crusher and steam engine combined and a ball mill are other machines in this large and impressive exhibit. It is a preparation for a visit to the Krupp Gun building. This stands behind a wall resembling a fortification on the lake front very near the Convent of La Rabida. Its dimensions are 85 feet by 300, with wings on each side 35 feet wide; its size and ornaments of sculptures and stucco work all contribute to make it a pretentious structure. The rear wall on the interior is adorned with pictures of historical interest connected with the Krupp family and the works.

The big coast gun, the largest in the world, occupies the central place on the main floor. It is 48 feet long, fires an explosive shell of 2,300 pounds a distance of 16 miles, and the expense of discharging it is $1,250. The gun was made in 1886, and has fired 16 shots. The other four guns mounted, beside the big one, are small only by comparison; one, the weight of whose barrel is more than 61 tons, is to be used on a man-of-war; another is for coast defense against ships, or to use on shipboard, with a modification of the ammunition lift. There are many other guns of smaller caliber.

The projectiles consist of steel armor shells for perforating ships and fortifications, steel fuse shells, made so that the charge explodes by a fuse on striking the mark; mine shells, cast iron fuse shells, shrapnels, used only in firing at animate objects, and case shots.

It is curious to note that these works also manufacture armor plate of about a foot in thickness, and capable of resisting projectiles of the largest caliber.

Some enormous plates stand against the front wall, with the cracks and holes which the projectiles beside them have made. No shell has gone through the nickel steel plates. As long as the man who makes the biggest guns continues to make plates that they cannot penetrate, the horrors of war are somewhat lessened.

But the Krupp Steel Works are not entirely devoted to these deadly weapons. Here is a hollow shaft from a block of crucible steel 82 feet long; near it are a screw shaft, thrust shaft and crank shaft, all of open-hearth steel. Their total weight is 103·34 tons and length 90 feet. They are to be placed in a North German Lloyd steamer. Centrifugal vessels, used for separating cream from milk, and capable of being driven at the rate of 10,000 revolutions a minute, are shown. There are also a locomotive frame of moulded steel, locomotive steam domes, hoisting cranes capable of lifting 83 tons, and many other minor articles.

A model of the humble "ancestral home" of the founder of the works, built in 1818, is among the objects of most interest. It is built of slate and brick, a little more than one story high. It is now used as an office by the proprietor of the works. Near this stands a model of the monument erected to the memory of Alfred Krupp by the officials and workmen in the works, and unveiled in 1892. The central figure is that of Mr. Krupp; the face is strong and manly, the attitude one of decision. The symbolic figures at the side represent "Humanity" and "Labor." At the base is Mr. Krupp's motto, "The object of labor should be the common good."

It is pleasant to pass from this proof of Germany's readiness for war to the Art Gallery, where is such abundant evidence of the triumphs of peace in her borders. Not only have artists sent their work, but many very choice paintings and sculptures have been loaned by the National Gallery of Berlin and by the state of Bavaria. The noble bronze statue of the Emperor William I., representing him when in the prime of life, is loaned by the Royal Academy of Berlin.

It is enough to say that there are 118 pieces of sculpture, 504 paintings, and 50 engravings, etchings, and prints, according to the catalogue, to show that it is impossible to give here any but a most unsatisfactory review of the work. Among the distinguished portraits may be mentioned first that of the young Emperor, by Prof. Max Koner, of Berlin. The treatment of the flesh texture and color and the textures of the coats is remarkable. Prof. Knaus' portraits of the historian Mommsen, seated in his library, and of the scientist Helmholtz, at a table with instruments upon it, are both most lifelike. So also are those by Prof. Von Senbach, of Munich, of Prince Bismarck, wearing a slouch hat and a severe look; and of Pope Leo, whose expression is mild, almost to weakness. The largest painting in the collection fills the entire end of the largest of the seven rooms allotted to Germany, and may, I suppose, be taken as an index of the loyalty of the nation to the memory of their first emperor. It is called "Apotheosis." It represents the old kaiser clad in ermine robes and seated in a chariot drawn by three fiery white horses. An angelic form holds a wreath above his head. A child, from whose grasp a string of corn flowers seems to have fallen, holds a medallion of the Empress Augusta (?) where the kaiser's eye may rest last upon it. Other angelic forms are in the clouds above. At the right are "Unser Fritz," wearing a laurel wreath and mounted on a black horse, and between him and his father are seen the faces of Bismarck and Von Moltke. On the other side are other men whose faces are not familiar. A herald, clad in armor and riding a spirited horse, leads the procession, waving a banner bearing the black eagle on a white field. It is the work of Prof. Ferd. Keller, of Karlsruhe, and owned by the nation.

"Theodor Korner after the sudden attack at Kitzen," by Otto Heichert, of Dusseldorf, is a picture of the poet soldier, which once seen cannot be forgotten.

There are many scenes from home life, touching and true. Among them should be mentioned "Children at Play," by Franz Ritter Defregger; "Harvesters Homeward Bound," by R. Henseler; "Once Upon a Time," by Hermann Kaulbach; and "At the Sick Bed," by Prof. Vautier, of Dusseldorf.

A small number of pictures bear the evidence that the artists have felt the influence of the "Impressionists" or, at least, that they paint what they see after the manner of that school.

It was a subject of much regret that Germany could be but poorly represented at our Centennial Exhibition. At the Columbian she has made such proof of her advanced position in science and art as to place other nations largely in her debt and to make her own people justly proud of *das Vaterland*.

A PROBLEM IN GLASSMAKING.*

By Dr. OTTO WITT.

IN almost all the provinces of technology there are a number of phenomena in the occurrence of which chemical and physical processes are so closely interwoven that it often becomes difficult to overcome the confusion and ascertain the exact cause. In this category must be placed the white panes of window glass which, in the lapse of years, assume a green or violet hue. Such panes of glass are occasionally seen in old houses; the older the structure, the more striking is the coloration. People who are averse to the effort of following things up to their origins say, when they are asked for the cause of such coloration, that the glass factories of former days were not capable of making such good white glass as is at present produced. But usually we observe in the same windows, containing such green and violet panes, several others of irreproachable whiteness, and our last doubts as to whether the green and violet glass was once equally acceptable disappear when we have occasion to take one of the colored plates out of its frame. We then see that at the edge of the plate, where the glass was embedded in putty, there is no trace of coloration. We thus at once detect the cause of the entire phenomenon. It can be nothing else than the light itself which, year after year, streams in a perfect flood through the uncovered part of the plate, while the edge, covered by putty, is protected from its action. The phenomenon is often observed to be most striking in the clearest and brightest glass. Only the best quality could have been chosen for covering the cupola-formed skylight of the old Pinakothek or art gallery at Munich. Several years ago many of these panes of glass gave forth a most beautiful purple-violet, while others of the same age remained perfectly colorless. By this time they have all doubtless been replaced by new panes, for the violet light which they emitted into the picture gallery began finally to prove very annoying in contemplating the pictures.

If, as is undoubtedly the case, not all glass plates, but only certain colorless ones, undergo such modifications as a result of exposure to the light of the sun for a number of years, some peculiarity or other in the production and chemical composition of such glass must be at fault. This is indeed the truth; the cause of the coloration of glass has been known for a long time, but the manner in which from this cause the effect is produced is ordinarily stated erroneously, even in books and articles which deal particularly with the technology of glass.

Ordinary window glass is produced by fusing together quartz sand, limestone, and soda. When these materials are perfectly pure and are not subjected to the slightest admixture during manipulation, a perfectly colorless glass is obtained, which in a hundred years would not be modified by the action of light. But here is the difficulty: perfectly pure materials are rare, and very slight quantities of iron combinations find their way only too readily into the composition of the glass, despite all precautions. Now the presence of iron, even in the very smallest traces, produces coloration in the glass, and this coloration varies according to circumstances. When in the form of the ferrous salt the iron exerts a much more pronounced coloring action than when present as oxide; in the first case the color produced is a deep bottle green, in the latter yellow. Accordingly, if the glassmaker has slight traces of iron in his mixture, he selects the proper means of transforming the iron into the oxide before proceeding with the manufacture of the glass. Thus he will be able to produce plates whose extremely light yellow coloration is no longer perceptible in the thin layer of glass, which may accordingly be considered colorless. But iron is peculiar, in that its oxide combinations are gradually transformed into ferrous salts by the action of sunlight. With some of these combinations the process is so ready and speedy that it may be utilized for photographic processes; with others it is much slower. Of the latter kind is ferric silicate, the coloring constituent of the above-mentioned yellowish glass. This salt likewise obeys the general law when long subjected to the action of sunlight, and becomes converted into the ferrous silicate, which is colored green; and since, as stated before, the coloring power of this salt is incomparably greater than that of the oxide salt from which it was produced, the green color now imparted to the glass is very pronounced, whereas the previous yellow tint was not perceptible. Thus it happens that window panes which at the outset were colorless may become green in the course of years.

But how do we account for the more frequent occurrence of the violet tint in the glass plates? In a last analysis this phenomenon is found to rest upon the same cause, the process, however, being complicated by an additional factor. When the quantity of the iron is tolerably large, the coloration of the glass through the transformation of the iron into oxide cannot be altogether prevented. The yellow hue of the glass remains distinctly perceptible. But in this case the glassmaker adds a substance to the glass which under ordinary circumstances would color it violet.

* Translated from *Prometheus*.—*Bulletin of Pharmacy*.

Manganese will serve this purpose. When combinations of manganese are added in the proper proportion to glass which is colored yellow by iron, the two complementary colors merge into each other reciprocally and the double colored glass appears colorless. This is a purely physical process which, in modified form, is not seldom resorted to in other branches of technology. The manganese is added to the glass in the form of superoxide of manganese, and this mineral salt receives the name of "glassmaker's soap," in the glass factories, because it has the property of washing colored glass white. The glassmaker utilizes this soap all the more willingly, inasmuch as on introducing it into the white, glowing, molten mass, oxygen is developed and thus the oxidation of the iron into oxide and the compensation of the yellow oxide coloration are both simultaneously effected. In this way the iron coloration, masked by the violet of the manganese, is hidden from the human eye, but not from the effect of the good old sun. The latter performs his office unperturbed, and slowly but surely transforms the ferric oxide salt into the green ferrous salt. Now green and violet are not reciprocally compensating, as are yellow and violet; on the contrary, their effects are added together, forming a somewhat bluish violet, and thus in this shade developed in the window plates modified by long exposure to the sun. In our day, since we have become familiar with the peculiar phenomena of iron-bearing and discolored glass, we seek, by careful selection of materials as free from iron as possible, to manufacture glass which is colorless and so remains; but inasmuch as the effect of the sunlight upon glass becomes perceptible only after the lapse of decades, we of course cannot tell how many of the panes of glass which are now inserted into our windows as colorless will deserve this designation after the lapse of a generation.

In America, where nothing is more highly prized than that which bears on its brow the stamp of venerable age (because there antiquity is the greatest rarity), glass plates which have become green or violet in the course of time are more admired and are looked upon as "aristocratic." Among us the venerable character of things begins only when their age may be computed by centuries, and we accordingly grow very enthusiastic over the "Butzenscheiben,"* whose origin we must seek back in the mediæval ages, and which in our eyes are worth their weight in gold when genuine. There are, however, irreverent people on this side as well as on the other side of the ocean, to whom a clear, colorless pane of glass, incapable of modification, is most desirable.

* Little square panes of colored glass, bearing a raised and inscribed circle.

EMPLOYMENT OF WOMEN AND CHILDREN IN FRANCE.

WE extract from the *Annales Industrielles* the text of a decree recently promulgated in France respecting the employment of women and children in unhealthy or dangerous trades: Art. 1. The employment is forbidden of children under eighteen years of age, of girls who are minors, and of women in all operations relating to the lubrication, the cleaning, the inspection and the repairs of machinery or mechanical apparatus in motion. Art. 2. The same class of persons is not allowed to work in factories in which machines, actuated either by hand or mechanical power, have not their dangerous parts protected by covers, guards, shields or appliances of a similar character. Art. 3. It is forbidden to employ children under the same age to turn apparatus receiving motion from a treadle, or to turn horizontal wheels. Art. 4. Children under sixteen years of age are not to be put to turn vertical wheels for a period longer than half a day's work, broken by a rest of at least half an hour; and also are not permitted to substitute treadle for hand work. Arts. 5 and 6. These articles prohibit the employment of persons under the same age in the manipulation of circular or ribbon saws and of shearing and other mechanical cutting blades. Art. 7. In glassworks children under thirteen are not to be employed in gathering up and blowing glass. Between the ages of thirteen and sixteen they are not to gather up a weight of glass exceeding two and a quarter English pounds. Unless above the age of sixteen, the blowing of glass is interdicted to them in bottle and window glass factories; and wherever the blowing is done by the mouth, a separate ferrule shall be provided for each person under eighteen. Art. 8. No child under sixteen shall be set to attend to steam cocks. Art. 9. Children under sixteen are not to be employed as collectors in workshops where wire drawing is carried on; at the same time this provision does not apply to cases where the work of the collectors is protected by guards. Art. 10. It is forbidden to have any work executed by children under the same age which is effected by means of flying scaffolding, as in the cleaning and repair of buildings. Art. 11. Young workmen and workwomen under eighteen are not to be allowed to carry—either inside or outside manufactories, workshops, building yards or mills—loads above the following weight: Boys under fourteen, 22 lb.; boys from fourteen to eighteen, 33 lb.; girls under sixteen, 11 lb.; girls from sixteen to eighteen, 23 lb. Neither within industrial establishments nor along the public thoroughfares shall the same young persons drag or push loads which shall demand a greater effort of strength than what suffices to lift and carry the weights already scheduled. The equivalent conditions applicable to the two descriptions of work will be determined by a ministerial order. Art. 12. No girl under sixteen years of age shall be allowed to work a treadle sewing machine. Art. 13. Children, girls and women shall not be employed in the preparation of writings, publications, notices, drawing, engravings, pictures, paintings, emblems, images, or other articles of which the offer, sale, exhibition, placarding or distribution is contrary to the provisions of the penal laws relating to morality. It is also forbidden to employ children under sixteen, girls, and women in the production of the above-named articles, which, although not of a character to bring them under the law, are yet calculated to have an immoral tendency. Arts. 14, 15 and 16. In certain establishments alluded to in a "table" annexed to the decree, the employment of persons under eighteen, and of girl minors and women, is interdicted; and in another "table" a similar prohibition attaches to the first class of workers with respect to certain other premises; and in a third "table," certain specified conditions must be complied with in the case of children, girl minors and women. Art. 17. The Minister of Commerce, Industry and the Colonies is charged with the execution of the present decree.

ON THE TRANSMISSION OF ELECTRIC SIGNALS THROUGH SPACE.*

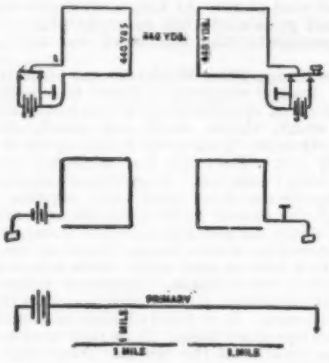
By W. H. PREECE, F.R.S.

THE author began by referring to the work of Henry in 1842, who transmitted signals by magnetized needles and Leyden jars 30 ft. away. Disturbances on telephone lines and induction between them and telegraph wires was touched upon, as well as Mr. Edison's method of utilizing the electrostatic influence between a pole line circuit beside a railway track and a telephone circuit on a moving train in 1885. Experiments to discover whether the effects observed in England were independent of the earth, and also to determine how far such inductive influences extended, were made by the author in the same year. It was found that on ordinary working telegraph lines the disturbance reached a distance of 3,000 ft., while effects were detected on parallel lines of telegraph from 10 to 40 miles apart in some sections of the country. In the latter instances, however, the presence of a network of wires between those experimented upon may have introduced electrostatic effects. Two lines were therefore selected 14 miles long and about 4½ miles apart, where no intermediate wires existed.

If we have two parallel conductors separated from each other by a finite space, and each forming part of a separate and distinct circuit, either wholly metallic or partly completed by the earth, and called respectively the *primary* and the *secondary* circuit, we may obtain currents in the secondary circuit either by conduction or by induction, and we may classify them into those due to—1. Earth currents. 2. Electrostatic induction. 3. Electromagnetic induction. It is very important to eliminate (1), which is a case of conduction, from (2) and (3), which are cases of induction.

Since 1885 the author has made a vast number of experiments in order to thrash out the laws and conditions that determine the distance at which magnetic disturbances can be usefully evident. The instrument used to receive these signals has been generally the telephone, but many absolute measurements have been made with a very sensitive reflecting galvanometer.

I.—To prove that the effects were due to electromagnetic induction. Conductors of copper wire insulated with gutta-percha were formed into quarter-mile squares and laid on a level plain a quarter of a mile apart, as in Fig. 1. Arrangements were made for sending vibratory or alternating currents which could be broken into Morse signals by means of a telegraph key. Telephones were used as receivers, which transformed these signals into buzzing dots and dashes. On closing the circuit in one square and sending signals, conversation could be readily held between the two operators by means of the Morse code. Obviously earth conduction could play no part in this transmission of signals, for the squares were insulated throughout from the earth. Next, in order to ascertain to what extent, if any, electrostatic effects were observable, one pole of the battery used was put to earth, and the further end of each square was disconnected.



FIGS. 1, 2 AND 3.

By this arrangement the mean electric force of one square was doubled, as compared with the former experiment, where the circuit was completed, but no effect was observed in the second square, either in the receiving telephone or with the reflecting galvanometer. The squares were even superposed at a distance of only 15 ft. apart, the upper one being suspended on poles, and the lower one lying on the ground, but without any result. Hence, the effects observed in this experiment were clearly due to electromagnetic induction.

II.—To prove that the effects increased directly with the strength of the primary current used and diminished with the resistance of the secondary current. (*a*) Two quarter-mile squares of insulated wire, Fig. 2, were opposed to one another, the distances between the front faces varying from 8 yards to 192. Currents of one and two amperes respectively were sent into one square, and the induced effect in the second square with two amperes was invariably twice that with one ampere. The measurements were made with a reflecting galvanometer. (*b*) Open wires were placed parallel to one another, a mile apart horizontally, Fig. 3. The primary circuit was two miles long. The other, the secondary circuit, was divided into two equal one mile lengths. With a primary current of 0·22 ampere the vibrations were just audible in a telephone fixed to either of the single mile lengths of the secondary, the total resistance in the latter circuit being 85 ohms. With a similar current (0·22 ampere) in the primary and the secondaries joined into a two-mile length, the same limit of audibility was reached when the resistance in the secondary was doubled, that is, it was raised to 170 ohms. Next, the current in the primary was doubled or increased to 0·44 ampere; and with a one-mile secondary the total resistance had to be doubled in order to reach the same limit. Finally, when the current in the primary was raised to 0·88 ampere—four times the original figure—then the same limit was reached when the resistance was quadrupled.

Experiments were also made to find how the effects varied with the length of the inductive system and with the distance separating them. The law for variation of length and distance is very complicated and depends wholly on the form of the circuit and its various reactions.

The Bristol Channel proved a very convenient locality to test the practicability of communicating across a distance of three and five miles without any intermediate conductors. On the shore, two copper wires, weighing 400 lb. per mile, combined in one circuit, were suspended on poles for a distance of 1,267 yards, the circuit being completed by the earth. On the sands, at low water mark, 600 yards from this primary circuit and parallel to it, two ordinary gutta-percha covered copper wires and one bare copper wire were laid down, their ends being buried in the ground by means of bars driven in the sand. One of the gutta-percha wires was lashed to an iron wire to represent a cable. These wires were periodically covered by the tide, which rises here at spring to 33 ft. On the Flat Holm, 3·1 miles away, another gutta-percha covered copper wire was

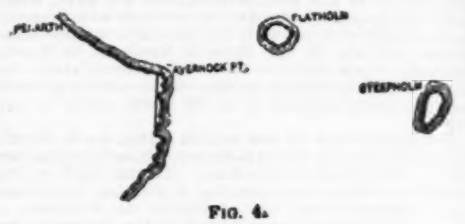


FIG. 4.

laid for a length of 600 yards. Fig. 4 shows a map of the field of operation.

There was also a small steam launch, having on board several lengths of gutta-percha covered wire. One end of such a wire, half a mile long, was attached to a small buoy, which acted as a kind of float to the end, keeping the wire suspended near the surface of the water as it was paid out while the launch slowly steamed ahead against the tide. Such a wire was paid out and picked up in several positions between the primary circuit and the islands.

The apparatus used on shore was a two horse power portable Marshall's steam engine, working a Pike & Harris' alternator, sending 192 complete alternations per second, with a voltage of 150 and of any desirable strength up to a maximum of 15 amperes. These alternating currents were broken up into Morse signals by a suitable key. The signals received on the secondary circuits were read on a pair of telephones, the same instruments being used for all the experiments. The object of the experiments was not only to test the practicability of signaling between the shore and the lighthouse, but to differentiate the effects due to earth conduction from those due to electromagnetic induction, and to determine the effects in water.

It was possible to trace, without any difficulty, the region where the lines of current flow ceased to be perceptible as earth currents and where they commenced to be solely due to electromagnetic waves. This was found by allowing the paid-out cables suspended near the surface of the water to sink. Near the shore no difference was perceptible, whether the cable was near the surface or lying on the bottom, but a point was reached, just over a mile away, where all sounds ceased as the cable sank, but were recovered again when the cable came to the surface.

The total absence of sound in the submerged cable leads to the conclusion either that the electromagnetic waves of energy are dissipated in the sea water, which is a conductor, or else that they are reflected away from the surface of the water like rays of light.

There was no difficulty in communicating between the shore and Flat Holm, and messages were read. The distance between the two places was 3·1 miles. The attempt to speak between Lavernock and Steep Holm was not so successful. The distance was 5·35 miles, but though signals were perceptible, communication was impossible. The fact indicated by the formula for parallel wires that the limiting distance increases directly with the square of the length of the circuits, has a very important bearing on the practical results of these experiments, for it shows that if we can make the length of the two lines long enough, it would be easy to communicate across a river or a channel.

There is little doubt that two wires, 10 miles long, could signal through a distance of 10 miles with ease. Although communication across space has thus been proved to be practical in certain conditions, those conditions do not exist in the cases of isolated lighthouses and lightships—cases which it was specially desired to provide for. The length of the secondary must be considerable, and for good effects, at least equal to the distance separating the two conductors. Moreover, the apparaus to be used on each circuit is cumbrous and costly, and it may be more economical to lay an ordinary submarine cable. Still, communication is possible, even between England and France, across the channel, and it may happen that between islands where the channels are rough and rugged, the bottom rocky and the tides fierce, the system may be financially practical. It is, however, in time of war that it may become useful. It is possible to communicate with a beleaguered city either from the sea or on the land, or between armies separated by rivers, or even by enemies.

A use to which these electromagnetic disturbances can be applied is to indicate to ships their contiguity to lighthouses and landfalls. Experiments are being made in this direction by Mr. Stevenson, of the North-

* Abstract of a paper read at the International Electrical Congress, Chicago, August 21-26, 1893.

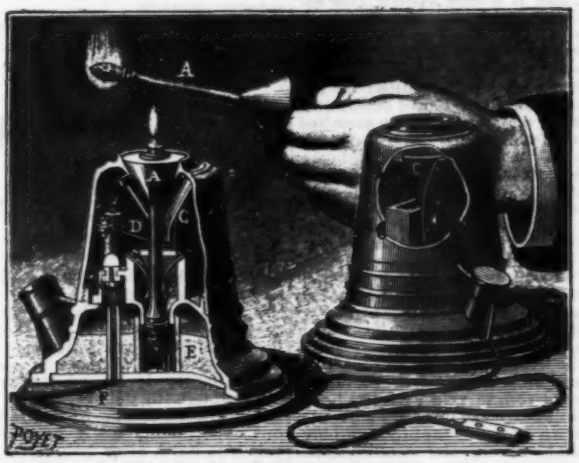
ern Lights Commission, on the coast of Scotland, but no results have yet been published. He proposes to submerge a cable on a given fathom line through which special automatic distinguishing signals are being sent, so that a ship approaching or crossing this line can pick up these signals on board and learn her true position by day or night independent of fog.

THE ELECTRIC MATCH.

THE apparatus represented herewith in external view and section is named by its inventor the *electric match*. It consists of a sort of bell provided with an aperture at the top. A rod, A, that enters this aperture constitutes the "match." When the rod is withdrawn from the apparatus it ignites, and the flame burns for a quarter of a minute. The apparatus is connected by two wires with a battery analogous to those used for electric call bells.

The metallic rod serving as a match is provided at its extremity with a perforated hollow cone filled with cotton. This cone enters, at the bottom of the apparatus, a reservoir filled with gasoline or with a mixture of alcohol and ether. When the rod is withdrawn it brings about the production of an electric spark, which ignites the cotton saturated with the inflammable liquid. The section shown gives the details of the different parts of the apparatus. A represents the match, properly so called, which enters a cylinder, B, closed by two flat springs when the match is withdrawn from the apparatus. C is a funnel opening in two parts to allow the match to pass. A piece of watch spring, D, constitutes a brush, and causes the formation of a spark in coming into contact with the cone. This brush is carried by an insulated copper rod that receives the current through the wire, F. The second wire is put in communication with the body of the apparatus.

At the bottom of the apparatus is the reservoir of



THE ELECTRIC MATCH.

inflammable liquid. This reservoir is filled with disks of felt to render the liquid immovable. A tubulure provided with a screw cap at the bottom of the apparatus permits of filling the reservoir when it is exhausted.—*La Nature.*

[NATURE.]

SIMPLIFIED MULTIPLICATION.

THE object of this note is to explain a process of simplifying multiplication. To most people multiplication by 2, 3, 4, 5 is *sufficiently* easy (and not worth incurring any trouble to make easier); whereas multiplication by 6, 7, 8, 9 is decidedly more difficult, so is *sometimes* worth while simplifying.

Now, by admitting the use of *negative digits* (which may be marked by a minus sign placed over the digit), we may write—

$$6 = 10 - 4 = 1\bar{4},\ 7 = 10 - 3 = 1\bar{3},\ 8 = 10 - 2 = 1\bar{2},$$
$$9 = 10 - 1 = 1\bar{1}.$$

This notation is pretty concise, being no longer than the ordinary notation when ever the extreme left hand digit is < 5, thus—

$$17 = 2\bar{3},\ 39 = 4\bar{1},\ 278 = 3\bar{2}\bar{2},\ 196 = 20\bar{4},\ \text{etc.}$$

while it requires one digit more than the ordinary notation when the extreme left-hand digit is not <5, and is followed by a negative digit, thus—

$$99 = 10\bar{1},\ 789 = 1\bar{2}1\bar{1},\ 676 = 1\bar{3}2\bar{4},\ 5678 = 14\bar{3}2\bar{2},\ \text{etc.}$$

The preparation of a number so as to contain no digit >5 (by introduction of negative digits, each not >5) will be called (for shortness) *Reduction:* the process is so very simple that the "reduced" number can always be *written down at sight* (a most important matter).

To form the product P of two given numbers M, N, either one or both of the factors M, N may be "reduced" as a preliminary to multiplication. If both factors be reduced, the rule of signs of algebraic multiplication must be used, viz.:

$+ \times + = +$, and $- \times - = +$; but $+ \times - = -$, and $- \times + = -$.

This "reduction" of both factors is particularly useful when many large digits occur in succession in both factors, in which case the whole of the multiplication can often be done mentally (without even writing out at length), thus—

$$99^2 = 10\bar{1}^2 = 10\bar{2}01 = 9801$$
$$999^2 = 100\bar{1}^2 = 100\bar{2}001 = 998001$$
$$998^2 = 100\bar{2}^2 = 1004004 = 996004$$

The following factors become particularly simple by this "reduction," viz.:

$999\ldots9 = 1000\ldots\bar{1}$, $\quad 888\ldots9 = 1\bar{1}1\bar{1}\ldots\ldots\bar{1}$
$777\ldots8 = 1\bar{2}2\bar{2}\ldots\ldots\bar{2}$, $\quad 666\ldots7 = 1\bar{3}3\bar{3}\ldots\ldots\bar{3}$

When the results cannot be readily done mentally, the multiplication may be done by writing out at length *in the usual way* (attending of course to signs), thus—

$89 = 1\bar{1}\bar{1}$ $\qquad$ $789 = 1\bar{2}\bar{1}\bar{1}$
$89 = 1\bar{1}\bar{1}$ $\qquad$ $789 = 1\bar{2}\bar{1}\bar{1}$

$\bar{1}\bar{1}\bar{1}$ $\qquad$ $\bar{1}\bar{2}\bar{1}\bar{1}$
$\bar{1}\bar{1}\bar{1}$ $\qquad$ $\bar{1}\bar{2}\bar{1}\bar{1}$
$1\bar{1}\bar{1}$ $\qquad$ $\bar{2}\bar{4}\bar{2}\bar{2}$
$1\bar{2}\bar{1}\bar{1}$

$\therefore 89^2 = 1\bar{2}\bar{1}\bar{2}1 = 7921$ $\qquad$ $\therefore 789^2 = 1\bar{4}\bar{2}\bar{2}\bar{5}\bar{2}1 = 622521$

It will be seen that the ease of the above procedure depends chiefly on the digits being so small (in both factors) as not to involve any *carrying* from digit to digit in the multiplications; this will always be the case when no digit exceeds 3 or $\bar{3}$ (because the greatest product $3 \times \bar{3} = 9$ only). But when the digits 4, 5, 6 occur *in either factor*, this will usually involve *carrying* in the multiplications (because 3×4 and 2×5 are both >9). In this case it is generally better to "reduce" one factor only, and by preference that factor which has the greatest number of large digits (*i. e.*, 7's, 8's, 9's), and further to use this factor as "multiplier," keeping the other factor unreduced as multiplicand. Further, it is often convenient in this case (especially when the factors are large) to completely separate the positive and negative products, add them separately, and finally take the difference of these sums; this will be the required product: this procedure (of using negative digits only in the multiplier, and then separating the + and − products) has the great advantages that (1) no further attention need be paid to the signs and (2) the final line has all its digits necessarily positive, so is itself the required product (in ordinary notation).

Ex.—Given M = 34,892, N = 89,795; to find M × N.

Choose N as "multiplier," because it contains four large digits. The work proceeds thus—

	34 892	= M
	110 215	= N
	174 460	= 5 × M
3 489 2		= 1 × M
3 489 374 460		= Positive sum = p
All negative.	348 92	= $\bar{1}$ × M
	6 978 4	= $\bar{2}$ × M
	348 92	= $\bar{1}$ × M
	356 247 32	= Negative sum = n
$\therefore p \ldots n$ =	3 133 127 140	= Product M × N

It will be seen that this process requires two more lines than the ordinary process (viz., the two lines p, n), but the *actual multiplications are far easier.*

It is obvious that the two lines p, n may be separately tested by the usual processes of "casting out the nines, elevens, etc."

The whole process above is so simple that it might well find a place in works on elementary algebra immediately after the explanation of the rule of signs in multiplication; it is thoroughly practical, and having been much used by the author, can be confidently recommended.

The use of negative digits, as above explained, may also be applied to the process of division, and in some cases with advantage. This application is, however, in general by no means quite easy, so cannot be recommended as a practically useful process.

[This process—as applied to multiplication—is not of course new; but it seems worth while to attempt to revive it now; as a process, somewhat the same in principle, has just been published (in the *Annales des Ponts et Chaussees* for April, 1893, p. 790) by Mr. Ed. Collignon. The only *actual multiplication* required in his process is by the digits 2 and 5; the elimination of actual multiplication by 3, 4, 6, 7, 8, 9 is of course an immense advantage. To this end he first shows how to "reduce" any number N to the algebraic sum (say $N_1 + N_2 - N_3$) of three others, N_1, N_2, N_3, composed solely of the four digits 0, 1, 2, 3. To multiply two numbers M, N, one of them, say N, is to be "reduced" as explained: the products MN_1, MN_2, MN_3 are then to be formed in the usual way; their algebraic sum $MN_1 + MN_2 - MN_3$ is the product required. The process has two decided defects, viz.—(1) the "reduction" of N is somewhat troublesome; (2) the forming and adding the three products ($MN_1 + MN_2 - MN_3$) is a good deal longer than the ordinary process.]

ALLAN CUNNINGHAM.

THE ACTION OF COLD AND WARMTH ON MUSCULAR FATIGUE.

FOLLOWING up Professor Mosso's researches on the pathology of fatigue, Dr. Patrizi contributes to the Journal of the Royal Academy of Medicine of Turin the results of a series of experiments by way of determining the action exerted by cold and warmth on the fatigue of the human muscle. The experiments were made by means of the "ergograph" (Professor Mosso's instrument), and consisted in the execution of a given piece of work—the lifting of a weight by the middle finger of the right hand, either by successive voluntary contractions or by contractions induced by electric irritation. The experiments, moreover, were conducted always at the same hours of the day, and comparison was made of the several tracings which were obtained while the forearm was kept in a bath of hot or cold water. The range of temperature within which the muscles act in executing a piece of work presents no appreciable alteration and is very wide—from 46° to 15° C. This fact Dr. Patrizi recognizes as "providential," seeing the different temperatures at which the muscles of the arm have to undergo fatigue in the ordinary conditions of life. The next result of the experiments goes to prove that with cold the work of the muscle rapidly diminishes—so much so as to become one fourth of the normal at 15° C., and fifteen times less than the normal at 10° C. On the other hand, above 46° C.—that is, between 46° and 47° C., the maximum limit of supportable heat—work undergoes a slight but constant diminution in all individuals. To explain this fact, confirmed as it is by other observations—a fact, moreover, not to be attributed to the dilatation of the vessels effected by heat and to consequent circulatory disturbance, because otherwise it would be manifested even at temperatures below 46° C.—Dr. Patrizi contends that the blood in the heated muscle is no longer capable of histological exchange, and that the toxic products of fatigue act more energetically on the muscle at high temperatures.—*The Lancet.*

YAWNING AS A REMEDY.

ACCORDING to current ideas, yawning in good society is an improper sign of weariness; according to the teachings of physiology, it is a long-drawn, forcible inspiration, followed by a shorter respiration; according to Naegeli, it is one of nature's many remedies, the proper application of which depends upon good judgment.

In yawning not only the muscles which move the lower jaw are used, but also the breathing muscles of the chest, and he who yawns to his heart's content also raises and extends the arms. In the deepest inspiration the chest remains extended for a short time, the eyes are almost or entirely closed, the ears somewhat raised, the nostrils dilated. Inside the mouth the tongue becomes round and arched, the palate stiffly stretched, and the uvula is raised, almost entirely closing the space between the nose and throat. At the beginning of the inspiration, cracking noise is heard in the ears, a proof that the duct leading to the hearing also succumbs to this stretching.

If the yawning has reached the deepest point, it will require from one to one and a half seconds for it to become noticeable to the hearing. To observe this, let one place himself at a sufficient distance from a clock, so that its ticking will not be easily heard, and yawn deeply. During this deep breathing the sound of the clock is not perceptible to the most careful listening. All this simply goes to show that yawning sets a number of muscles to work, and particularly those which are not subject to the will.

Although one yawning does not present a very agreeable appearance, it is very agreeable to himself, for the stretching of muscles causes a feeling of comfort; it acts like massage, and is the most natural gymnastics of the lungs imaginable. Dr. Naegeli, therefore, advises people not to concern themselves with so-called decency, but every morning and evening, and as often as possible, to exercise the lungs and all the muscles of respiration by yawning and stretching, as many chronic lung troubles may thus be prevented.

Dr. Naegeli orders the patient troubled with too much wax in the ear, accompanied with pain, to yawn often and deeply. He also, in cases of nasal catarrh, inflammation of the palate, sore throat and earache, orders the patient, as often as possible during each day, to yawn from six to ten times successively, and immediately after to swallow. The result will be surprising. If one looks upon yawning as a natural massage for certain organs, he will reach a satisfactory explanation of its curative properties.—*N. Y. Med. Times.*

THE ORIGIN OF SLEEP.

IF the sun always shone, we should never go to bed, sleep would not have been developed. It is true, nocturnal animals sleep and wake just as much as diurnal ones; and a drowsy owl, blinking and nodding in the garish light of daytime, is a familiar object for the unphilosophic contempt of the young, the gay, the giddy and the thoughtless. But then, all such animals are themselves descendants of creatures which were once for many ages diurnal; they learned the trick of alternate sleeping and waking while their ancestors were still well behaved day-roaming creatures; and when, like Tom and Jerry, they took incontinently to the vicious practice of "turning night into day," they merely reversed the usual process, long since become organic, and slept through the hours when the rest of the world was alive and waking. The habit itself, viewed abstractly, is one which could never have arisen except for the regular alternation of light and darkness.

There is no particular reason why we or any other animals should rest on an average about eight or nine hours out of every twenty-four (I accept the computation of a justly popular poem without further discussion), save for the fact that eight hours is about the average time during which there isn't light enough for an ordinary animal to get about with comfort at his usual avocations. If there are animals at all analogous to our own in Mars or Venus, we would naturally expect them to sleep and wake alternately for a period which would be entirely determined by the duration of day and night in their own planet. Observe, too, that this

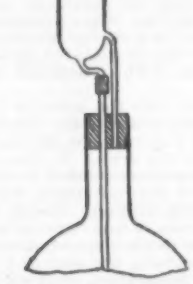
most fundamental distinction due to day and night is wholly relative to the sense of sight, and can affect only those types of life which are sufficiently high to have evolved for themselves eyes or something like them.

Plants, it is true, being dependent for their growth upon the chemical action of rays of sunlight that fall upon their surface, have an equally wide distinction of day functions and night functions with the highest animals; they eat and digest in the light, and grow or repair themselves through the hours of darkness. But the lowest animals have no such marked division of nocturnal and diurnal habits; with ceaseless industry they roll about through the waters by day and night alike, seeking by touch alone whom or what they may devour in their native medium. If they rest occasionally for digestion and repair, it is at irregular periods —sometimes for a few minutes, sometimes for hours or even days together. If you dry them up, they remain mummied for a year; if you moisten them once more, they start at once on their travels. In one word, they have no distinct periodicity of any sort. But as soon as eyes are evolved, and in proportion to the perfection and height of their development, animals begin to divide their lives markedly into two main portions—a waking and a sleeping one; a more and a less active. While light is supplied them abundantly to see their way about, they move around the world in search of food, or prey, or mates, or laying places; the moment night comes on, they retire to nests or lairs and become torpid and motionless.—*Cornhill Magazine.*

A GLASS INTERCEPTOR FOR DISTILLING.

By M. MULLER.

THE author recommends this equivalent to a catch box represented in the accompanying sketch as absolutely reliable in cases where particles of a boiling liquid might be spurted over and be carried along with vapors into the distillate. This apparatus has been found especially useful for the nitrogen determinations according to Kjehldahl's process.

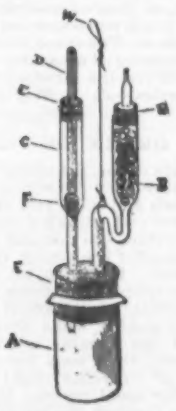


A CHEAP AND USEFUL FORM OF APPARATUS FOR THE GRAVIMETRIC DETERMINATION OF CO_2.

By J. H. HOSEASON.

IT must have occurred to all who have had occasion to employ any of the usual contrivances for the gravimetric estimation of CO_2 that the proportionate weight of instrument to substance is much too large for very accurate determination, especially when the quantity of CO_2 present is in small ratio. Most of these appliances are extremely fragile, and, moreover, expensive, disadvantages which do not apply to the one which I describe and figure.

To Make the Apparatus.—Draw off 2½ or 3 inches from the top of a ¾ inch or 1 inch diameter test tube, and while hot round the bottom by gently blowing into it, A. Fit with a perfectly sound cork, E, perforated by two holes of adequate size, through which the tubes, B and C (to be subsequently described), should pass, air-tight. The tubes, B and C, are made by slightly drawing out at the center 4 inches of glass tubing (¼ inch diameter), then cutting exactly in two; join each of these to tubing having about ⅓ of its caliber; bend one of them S shape, as shown in B. A small plug of absorbent cotton is placed at the bottom of B, which is then nearly filled with granular calcium chloride, and finally closed by means of a perforated cork, E, through which passes a small piece of tubing drawn out to a capillary. B constitutes the drying tube. The tube, C, when finished, is not unlike a syringe in appearance. It is fitted with a perforated cork, E, through which passes the piston, D. This should work loosely in E. The



piston, D, is made from some of the thin tubing by drawing to a point, then sealing both ends. On the pointed end is placed a piece of India rubber tubing, F. By heating the rod before attaching the rubber, the latter will be cemented to the former. A perfect valve is thus formed when D is firmly pressed into C. A copper wire, W, is useful to hang the apparatus on the hook of the balance.

To Use the Apparatus.—Slide up the cork E‴, press D well home, and fill two-thirds of C with 40 to 50 per cent. H_2SO_4; replace E‴; then proceed as with the other instruments.

In bringing my adaptation of the same old principle before you, I may state that its special advantages are: It is light, weighing from 5 to 6 grammes, whereas the instruments of Schrotter, Rohrbeck, Rose, and Geissler average from 20 to 30 grammes; it is inexpensive and simple, costing at a maximum 2d., a little time and manipulation: the aforementioned cost from 2s. 6d. to 4s. 6d. each. It is scarcely necessary for me to point out the advantages accruing to the student who endeavors to make his own apparatus, and I think the youth who does so gets a better grasp of the principles underlying his work—a point which I am afraid is sadly overlooked in the teaching of chemistry, and also other subjects.

I have found this arrangement to be cleanly and accurate.—*Chemist and Druggist.*

THE MORDANTS AND THEIR ACTION.

A WRITER in *Reimann's Faerber Zeitung* says: Dyestuffs are divided into three classes, according to their chemical character—acid, basic, and indifferent; and it would be well if mordants were similarly classified, on account of their varying character. He states that many dyers, without troubling themselves to ascertain whether or not one ingredient neutralizes the effect of the other, appear to try to use a combination of as many stuffs as possible, but such experiments are, as a rule, unsuccessful, and it is only when a dyer endeavors to understand thoroughly the chemical processes which take place in dyeing that he will succeed in attaining satisfactory results. The following hints are intended as a help toward this end. The painstaking researches of chemistry have resulted in the production of an ever-increasing number of substances which dye the fiber without mordant. These so-called "substantive" dyes are distinguished from the "adjective," which require the use of certain mordants, but the necessity of the latter does not depend upon the dyestuff only, but also upon the nature of the fiber to be dyed, and the same dye may be "substantive" in the case of wool and "adjective" in that of cotton, that is, it may require a mordant. For this reason, the above distinction has only a limited application. The basic dyes, which, as well as the acid dyes, enter commerce as salts, contain NH_2 groups, which mark their chemical peculiarities. If acids are applied to those, they combine with the amido groups, and form salts, but as mordants, only those acids are of value which produce with the color basis an insoluble or difficult soluble combination. This is true of tannic acid. The combination of tannic acid with the bases of the aniline dyes is insoluble in the ordinary solvents, but it becomes soluble if an excess of tannin is employed. It is probable that, among the combinations standing near to tannic acid, there are those that do not possess this tendency, and it would, without doubt, be useful to make experiments with reference to this. Up to the present time, it has been sought to counteract this evil in another way. The vegetable fiber, saturated with tannin, is treated with a soluble antimony salt, when a conversion takes place between the two agents, and then, if a basic dye is used for dyeing, it is certain that there is no excess of free tannin. As regards the basic dyes, it has been ascertained that other dyes may be employed as mordants for them. If alizarine be dissolved in ammonia and used for dyeing, and the H_2N be expelled by heating, the fiber is dyed a fugitive yellow, but absorbs the basic dye nevertheless. The benzidine dyes also serve as mordants for the basic dyes. While the latter require an acid mordant, the acid dyes require the opposite treatment; but we must separate from the acid dyes those which owe their acid character entirely, or principally, to the sulphonic acid group HSO_3, in dyeing with which, no mordant is used, but it is different with dyes that owe their acid character to the hydroxyl groups OH. They are, generally, in their purest condition, white, or faintly colored substances, which, if used without being combined with other substances, either dye badly, with a fugitive color, or do not dye at all. But the hydroxyl hydrogen of the hydroxyl dyes has the property of being replaced by metals, and then it gives admirable color combinations. Some of these metal combinations are soluble, but the larger number are insoluble, and the combinations of the latter kind are known as color lakes. As fast colors are principally desired, it is evident that combinations of the latter kind only must be used in the dye house, but their insolubility prevents them from being employed as ready formed dyes, and they must, therefore, be produced upon the fiber by color reaction. Of the several metals, sodium and potassium cannot be considered, because their combinations are soluble. Thus, for instance, alizarine with alkalies gives violet salts soluble in water, while the other salts are either not at all soluble or only partially so. For the formation of difficultly soluble or insoluble color lakes, alumina, the oxides of chrome, iron, tin, and copper, must be considered first. The generated color varies according to the metal used, while the quantity employed is also a factor. For instance, alizarine, with a little oxide of iron, gives lilac shades, while with a large quantity of the latter, a black color lake results. Alumina and oxide of tin generally give the same kind of color, and it is advisable to employ tin when the fiber is to be fulled during the operation of dyeing. As metallic oxides and earths form combinations insoluble in water, they cannot be used directly as mordants, but their salts, which are soluble in water, must be employed for this purpose. Among these, the preference is given to those that will decompose readily, and thereby precipitate their metallic part upon the fiber as insoluble oxides, as the more the former is saturated with the latter, the greater the quantity of dye it will absorb from the bath. Of the aluminum combinations, alum or sulphate of alumina complies best with these conditions. When mordanting with alum, the wool fiber decomposes this salt and absorbs alumina. The writer states that it is, perhaps, more advantageous to accomplish this decomposition in a chemical rather than in a physical manner by heat. As is well known, a precipitate of alumina is formed, if a solution of soda is added to one of alum. This same process will naturally take place upon the fiber, if it is first saturated with an alum solution, feebly wrung, and then passed through an alkaline bath (soda solution), but an excess of soda is to be avoided and the fiber must be rinsed subsequently. The use of the soda would be cheaper than mordanting at a boil, and time would be saved. A similar method might also be employed in other cases. Among other soluble alumina combinations, the acetate is employed, although it is so inconstant that it decomposes in the drying.—*Textile Industries.*

POROUS EARTHENWARE FILTERS.

By W. PUKALL.

POROUS earthenware has long been in use as a straining or filtering material for certain purposes, the porosity being sometimes increased by mixing with the clay carbonaceous or organic pulverulent material, subsequently burned off during the firing of the goods. As a rule this operation is not carried very far, so that a comparatively soft product results, hard-burned material being much less frequently employed. The author finds, however, that thoroughly hard-burned unglazed filters answer better, especially when made of a particular porcelain-like composition of kaolins of various kinds. A flask-shaped vessel of this special ware is the most convenient for use; it allows gases to diffuse through readily, although they will not pass *en masse* through the walls; aqueous fluids, on the other hand, readily pass through the pores, especially when some difference of pressure exists between the inside and outside. Mercury does not pass, even under 2·5 atmospheres pressure.

Fig. 1 illustrates these properties: the flask, *a*, is

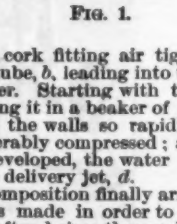


FIG. 1.

provided with a cork fitting air tight, through which passes the exit tube, *b*, leading into the closed bottle, *c*, containing water. Starting with the flask perfectly dry, on immersing it in a beaker of water, *c*, this fluid passes through the walls so rapidly that the air in *c* becomes considerably compressed; a small fountain is consequently developed, the water in *c* being forced out through the delivery jet, *d*.

The special composition finally arrived at after various experiments made in order to obtain the best result is so hard, after being thoroughly burned, as not to be scratched by steel, and is strong enough to resist wear and tear much better than soft earthenware goods such as terra cotta and the like materials. It is not attacked by acids or alkalies, whether in concentrated or dilute solution, whether hot or cold; while sufficiently porous to allow of pretty rapid passage of watery fluid, it will retain very finely divided or gelatinous precipitates, such as the hydroxides of iron, aluminum, and magnesium, barium sulphate precipitated cold, zinc, manganese, and tin sulphides, etc. Milk furnishes a perfectly clear effluent when placed inside a "balloon filter" of the kind, the oil particles being retained, while a watery fluid exudes. Similarly, starch paste yields a crystal-clear filtrate. In such cases filtration is greatly accelerated by connecting the interior of the porous flask with a water air pump or other means of exhaustion, and immersing the flask in the liquid to be filtered. The arrangement shown in Fig. 2 is convenient, the filter flask, *a*, being placed in-

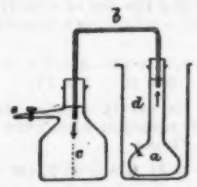


FIG. 2.

side the beaker, *d*, and connected with the filtrate reservoir, *c*, by the tube, *b*. This reservoir is exhausted by connecting the outlet of *c* with a filter pump, etc.; the stopcock, *e*, is then closed, and the whole left to itself for some time, *e. g.*, overnight. Precipitated substances may be thus collected and washed with facility, the crust of washed substance that forms round the flask being usually detachable with ease. When employed for rendering turbid fluids clear (*e. g.*, drinking water), the diminution in permeability brought about by the accumulation of solid particles is mostly removable by scrubbing the outer surface with sand, etc. The rapidity with which clear water traverses the walls is indicated by the following figures; three sets of five filters each were examined, each set having the capacity of 50, 135, and 1,000 c. c. respectively:

	Rate in c. c. per hour.		
	Maximum.	Minimum.	Average.
First set.....	5,100	4,680	4,875
Second "	9,042	8,118	8,623
Third "	34,200	28,020	29,628

Fig. 3 represents an automatic filtration arrangement whereby filtration under slightly diminished pressure is effected, the filtered liquid being drawn off from the

FIG. 3.

reservoir, *d*, from time to time by the cock, *e*.—*Jour. Soc. Chem. Industry.*

TURACIN, A REMARKABLE ANIMAL PIGMENT CONTAINING COPPER.*

By Prof. A. H. CHURCH, M.A., F.R.S.

THE study of natural coloring matters is at once peculiarly fascinating and peculiarly difficult. The nature of the coloring matters in animals and plants, and even in some minerals (ruby, sapphire, emerald, and amethyst, for example), is still, in the majority of cases, not completely fathomed.

Animal pigments are generally less easily extracted and are more complex than those of plants. They appear invariably to contain nitrogen—an observation in accord with the comparative richness in that element of animal cells and their contents. Then, too, much of the coloration of animals, being due to microscopic structure, and therefore having a mechanical and not a pigmentary origin, differs essentially from the coloration of plants. Those animal colors which are primarily due to structure do, however, involve the presence of a dark pigment—brown or black—which acts at once as a foil and as an absorbent of those incident rays which are not reflected.

Many spectroscopic examinations of animal pigments have been made. Except in the case of blood and bile pigments, very few have been submitted to exhaustive chemical study. Spectral analysis, when uncontrolled by chemical, and when the influence of the solvent employed is not taken into account, is very likely to mislead the investigator. And, unfortunately, the non-crystalline character of many animal pigments, and the difficulty of purifying them by means of the formation of salts and of separations by the use of appropriate solvents, oppose serious obstacles to elucidation. Of blood red or hæmoglobin it cannot be said that we know the centesimal composition, much less the molecular weight. Even of hæmatin the empirical formula has not yet been firmly established. The group of black and brown pigments to which the various melanins belong still awaits adequate investigation. We know they contain nitrogen (8½ to 13 per cent.), and sometimes iron, but the analytical results do not warrant the suggestion of empirical formulæ for them. The more nearly they appear to approach purity, the freer the majority of them seem from any fixed constituent such as iron or other metal. It is to be regretted that Dr. Krukenberg, to whom we are indebted for much valuable work on several pigments extracted from feathers, has not submitted the interesting substances he has described to quantitative chemical analysis.

I must not, however, dwell further upon these preliminary matters. I have introduced them mainly in order to indicate how little precise information has yet been gathered as to the constitution of the greater number of animal pigments, and how difficult is their study.

And now let me draw your attention to a pigment which I had the good fortune to discover, and to the investigation of which I have devoted I am afraid to say how many years.

It was so long ago as the year 1866 that the solubility in water of the red coloring matter in the wing feathers of a *plantain eater* was pointed out to me. [One of these feathers, freed from grease, was shown to yield its pigment to pure water.] I soon found that alkaline liquids were more effective solvents than pure water, and that the pigment could be precipitated from its solution by the addition of an acid. [The pigment was extracted from a feather by very dilute ammonia, and then precipitated by adding excess of hydrochloric acid.] The next step was to filter off the separated coloring matter, and to wash and dry it. The processes of washing and drying are tedious, and cannot be shown in a lecture. But the product obtained was a solid of a dark crimson hue, non-crystalline, and having a purple, semi-metallic luster. I named it *turacin* (in a paper published in a now long defunct periodical, *The Student and Intellectual Observer*, of April, 1868). The name was taken from "*Touraco*," the appellation by which the *plantain eaters* are known—the most extensive genus of this family of birds being *Turacus*.

From the striking resemblance between the color of arterial blood and that of the red touraco feathers, I was led to compare their spectra. Two similar absorption bands were present in both cases, but their positions and intensities differed somewhat. Naturally I sought for iron in my new pigment. I burnt a portion, dissolved the ash in hydrochloric acid, and then added sodium acetate and potassium ferrocyanide. To my astonishment I got a precipitate, not of Prussian blue, but of Prussian brown. This indication of the presence of copper in turacin was confirmed by many tests, the metal itself being also obtained by electrolysis. It was obvious that the proportion of copper present in the pigment was very considerable—greatly in excess of that of the iron (less than 0·5 per cent.) in the pigment of blood.

Thus far two striking peculiarities of the pigment had been revealed, namely, its easy removal from the web of the feather and the presence in it of a notable quantity of copper. Both facts remain unique in the history of animal pigments. The solubility was readily admitted on all hands, not so the presence of copper. It was suggested that it was derived from the Bunsen burner used in the incineration, or from some preservative solution applied to the bird skins. And it was asked, "How did the copper get into the feathers?" The doubters might have satisfied themselves as to copper being normally and invariably present by applying a few easy tests and by the expenditure of half a crown in acquiring a touraco wing. My results were, however, confirmed (in 1872) by several independent observers, including Mr. W. Crookes, Dr. Gladstone, and Mr. Greville Williams. And in 1873, Mr. Henry Bassett, at the request of the late Mr. J. J. Monteiro, pushed the inquiry somewhat further. I quote from Monteiro's "Angola and the River Congo," published in 1875 (vol. ii., pp. 75–77). "I purchased a large bunch of the red wing feathers in the market at Sierra Leone, with which Mr. H. Bassett has verified Professor Church's results conclusively," etc., etc. Mr. Bassett's results were published in the *Chemical News* in 1873, three years after the appearance of my research in the *Phil. Trans.* As concentrated hydrochloric acid removes no copper from turacin, even on boiling, the metal present could not have been a mere casual impurity; as the proportion is constant in the turacin obtained from different species of touraco, the existence of a single definite compound is indicated. The presence of traces of copper in a very large number of plants, as well as of animals, has been incontestably established. And, as I pointed out in 1868, copper can be readily detected in the ash of banana fruits, the favorite food of several species of the "turacin bearers." The feathers of a single bird contain on the average 2 grains of turacin, corresponding to 0·14 of a grain of metallic copper; or, putting the amount of pigment present at its highest, just one-fifth of a grain. This is not a large amount to be furnished by its food to one of these birds once annually during the season of renewal of its feathers. I am bound, however, to say that in the blood and tissues of one of these birds, which I analyzed immediately after death, I could not detect more than faint traces of copper. The particular specimen examined was in full plumage. I conclude that the copper in its food, not being then wanted, was not assimilated.

Let us now look a little more closely at these curious birds themselves. Their nearest allies are the cuckoos, with which they were formerly united by systematists. It has, however, been long conceded that they constitute a family of equal rank with the Cuculidæ. According to the classification adopted in the Natural History Museum the order Picariæ contains eight suborders, the last of which, the Coccyges, consists of two families, the Cuculidæ and the Musophagidæ. To the same order belong the hoopoes, the trogons, the woodpeckers. The plantain eaters or Musophagidæ are arranged in six genera and comprise twenty-five species. In three genera—Toracus, Gallirex, and Musophaga—comprising eighteen species, and following one another in zoological sequence, turacin occurs; from three genera (seven species)—Corythæola, Schizorhis, and Gymnoschizorhis—the pigment is absent. [The colored illustrations to H. Schlegel's Monograph (Amsterdam, 1860) on the Musophagidæ were exhibited.] The family is confined to Africa; eight of the turacin bearers are found in the west sub-region, one in the southwest, two in the south, two in the southeast, four in the east, two in the central, and two in the northeast. It is noteworthy that, in all these sub-regions, save the southeast, turacin bearers are found along with those plantain eaters which do not contain the pigment. Oddly enough two of the latter species, *Schizorhis africana* and *S. zonura*, possess white patches destitute of pigment in those parts of the feathers which in the turacin bearers are crimson. These birds do not—I will not say cannot—decorate these bare patches with this curiously complex pigment. [Some extracts were here given from the late Mr. Monteiro's book on Angola (vol. ii., pp. 74—79), and from letters by Dr. B. Hinde. These extracts contained references to curious traits of the touracos.]

Usually from twelve to eighteen of the primaries or metacarpo-digitals and secondaries or cubitals among the wing feathers of the turacin bearers have the crimson patches in their web. Occasionally the crimson patches are limited to six or seven of the eleven primaries. I have observed this particularly with the violet plantain eater (*Musophaga violacea*). In these cases the crimson head feathers, which also owe their color to turacin, are few in number, as if the bird, otherwise healthy, had been unable to manufacture a sufficiency of the pigment. I may here add that the red tips of the crest feathers of *Turacus meriani* also contain turacin.

In all the birds in which turacin occurs this pigment is strictly confined to the red parts of the web, and is there unaccompanied by any other coloring matter. It is therefore found that if a single barb from a feather be analyzed, its black base and its black termination possess no copper, while the intermediate portion gives the blue-green flash of copper when incinerated in the Bunsen flame. [A party-colored feather was burnt in the Bunsen flame, with the result indicated.]

Where it occurs, turacin is homogeneously distributed in the barbs, barbicels, and crochets of the web, and is not found in granules or corpuscles.

To the natural question "Does turacin occur in any other birds besides the touracos?" a negative answer must at present be given. At least my search for this pigment in scores of birds more or less nearly related to the Musophagidæ has met with no success. In some of the plantain eaters (species of Turacus and Gallirex) there is, however, a second pigment closely related to turacin. It is of a dull grass green color, and was named turacoverdin by Dr. Krunkenberg in 1881. I had obtained this pigment in 1868 by boiling turacin with a solution of caustic soda, and had figured its characteristic absorption band in my first paper (*Phil. Trans.*, vol. clix., 1870, p. 630, fig. 4). My product was, however, mixed with unaltered turacin. But Dr. Krukenberg obtained what certainly seems to be the same pigment from the green feathers of *Turacus corythaix*, by treating them with a 2 per cent. solution of caustic soda. I find, however, that a solution of this strength dissolves, even in the cold, not only a brown pigment associated with turacoverdin, but ultimately the whole substance of the web. By using a much weaker solution of alkali (one part to a thousand of water) a far better result is obtained. [The characteristic absorption band of turacoverdin, which lies on the less refrangible side of D, was shown; also the absorption bands of various preparations of turacin.] I have refrained from the further investigation of turacoverdin, hoping that Dr. Krunkenberg would complete his study of it. At present I can only express my opinion that it is identical with the green pigment into which turacin when moist is converted by long exposure to the air or by ebullition with soda, and which seems to be present in traces in all preparations of *isolated* turacin, however carefully prepared.

A few observations may now be introduced on the physical and chemical characters of turacin. It is a colloid of colloids. And it enjoys in a high degree one of the peculiar properties of colloids, that of retaining, when freshly precipitated, an immense proportion of water. Consequently, when its solution in ammonia is precipitated by an acid, the coagulum formed is very voluminous. [The experiment was shown.] One grm. of turacin is capable of forming a semi-solid mass with 600 grms. of water. Another character which turacin shares with many other colloids is its solubility in pure water and its insolubility in the presence of mere traces of saline matter. It would be tedious to enumerate all the observed properties of turacin, but its deportment on being heated and the action of sulphuric acid upon it demand particular attention.

At 100° C., and at considerably higher temperatures, turacin suffers no change. When, however, it is heated to the boiling point of mercury it is wholly altered. No vapors are evolved, but the substance becomes black and is no longer soluble in alkaline liquids, nor, when still more strongly heated afterward, can it be made to yield the purple vapors which unchanged turacin gives off under the same circumstances. This peculiarity of turacin caused great difficulty in its analysis, for these purple vapors contain an organic crystalline compound in which both nitrogen and copper are present, and which resist further decomposition by heat. [Turacin was so heated as to show its purple vapors, and also the green flame with which they burn.] This production of a volatile organic compound of copper is perhaps comparable with the formation of nickel and ferro-carbonyl.

The action of concentrated sulphuric acid upon turacin presents some remarkable features. The pigment dissolves with a fine crimson color, and yields a new compound, the spectrum of which presents a very close resemblance to that of hæmatoporphyrin [turacin was dissolved in oil of vitriol; the spectrum of an ammoniacal solution of the turacoporphyrin thus produced was also shown], the product obtained by the same treatment from hæmatin; in other respects also this new derivative of turacin, which I call turacoporphyrin, reminds one of hæmatoporphyrin. But, unlike this derivative of hæmatin, it seems to retain some of its metallic constituent. The analogy between the two bodies cannot be very close, for if they were so nearly related as might be argued from the spectral observations, hæmatin ought to contain not more but less metal than is found to be present therein.

The percentage composition of turacin is probably: Carbon, 53·60; hydrogen, 4·6; copper, 7·01; nitrogen, 6·96; and oxygen, 27·74. These numbers correspond pretty nearly to the empirical formula, $C_{52}H_{51}Cu_2N_9O_{12}$. But I lay no stress upon this expression.

I have before said that copper is very widely distributed in the animal kingdom. Dr. Giunti, of Naples, largely extended (1881) our knowledge on this point. I can hardly doubt that this metal will be found in traces in all animals. But besides turacin only one organic copper compound has been as yet recognized in animals. This is a respiratory, and not a mere decorative pigment like turacin. Leon Fredericq discovered this substance, called hæmocyanin. It has been observed in several genera of Crustacea, Arachnida, Gastropoda, and Cephalopoda. I do not think it has ever been obtained in a state of purity, and I cannot accept for it the fantastic formula—$C_{291}H_{1515}CuS_4O_{315}$—which has recently been assigned to it. On the other hand, I do not sympathize with the doubts as to its nature which F. Heim has recently formulated in the *Comptes Rendus*.

It is noteworthy, in connection with the periodic law, that all the essential elements of animal and vegetable organic compounds have rather low atomic weights—iron, manganese, and copper representing the superior limit. Perhaps natural organic compounds containing manganese will some day be isolated, but at present such bodies are limited to a few containing iron, and to two—hæmocyanin and turacin—of which copper forms an essential part.

If I have not yet unraveled the whole mystery of the occurrence and properties of this strange pigment, it must be remembered that it is very rare and costly, and withal difficult to prepare in a state of assured purity. It belongs, moreover, to a class of bodies which my late master, Dr. A. W. Von Hofmann, quaintly designated as "dirts" (a magnificent dirt truly!)—substances which refuse to crystallize and cannot be distilled. I have experienced, likewise, during the course of this investigation, frequent reminders of another definition propounded by the same great chemist, when he described organic research as "a more or less circuitous route to the sink"!

I am very glad to have had the opportunity of sharing with an audience in this institution the few glimpses I have caught from time to time during the progress of a tedious and still incomplete research into the nature of a pigment which presents physiological and chemical problems of high if not of unique interest.

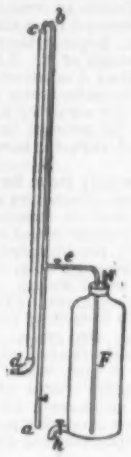
Let my last word be a word of thanks. I am indebted to several friends for aid in this investigation,

* A lecture delivered at the Royal Institution of Great Britain, Friday, February 17, 1893.

and particularly to Dr. MacMunn, of Wolverhampton, the recognized expert in the spectroscopy of animal pigments.

TRANSFERRING WASH SOLUTIONS.

THE tube, *a*, *b*, is kept full and gently overflowing with water by connection at *a* with the town water supply, the excess being conducted to a sink through the pipe, *c*, *d*. When the cock, *e*, is opened the tube, *a*, *b*, tends to empty itself into the large bottle, F, which at the start is full of air. The air in F is consequently under pressure to a degree determined by the height of the column of water in *a*, *b*, and the pressure under which it is flowing out at *b*. This com-

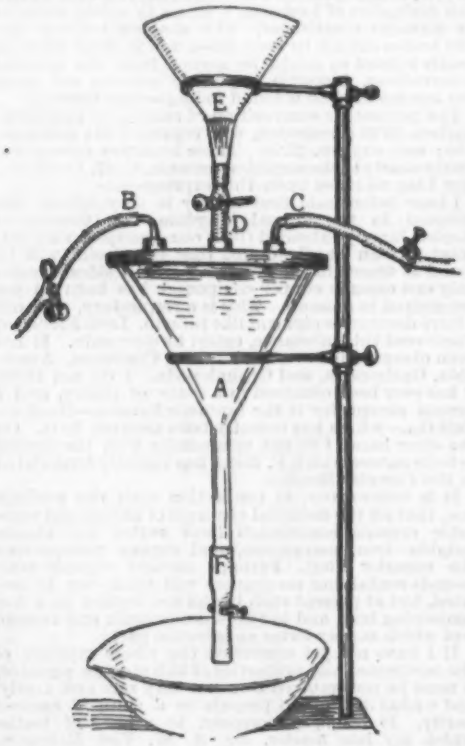


pressed air is conducted by ¼ inch lead piping to various convenient parts of the laboratory, where any wash bottle with the customary short and long tubes may be attached by its short tube, and the wash water delivered through a nozzle. In the laboratory of the authors the bottle used is one large enough to suffice for half a day's continuous use, after which the water is allowed to drain into the sink by opening the cock, *h*.

A WASH FUNNEL FOR OXIDIZABLE PRECIPITATES.

By J. A. FORRET.

THE funnel, A, is fitted with a perforated metal cone, and covered with a circular piece of wood carrying three glass tubes (B, C, and D), to which are attached India rubber tubes furnished with spring clips. The wooden cover has also a glazed aperture as large as the diameter of the funnel will admit, to enable the operator to see the contents of the funnel. To the stem of A is fitted a piece of India rubber tubing, F, into the other end of which a short glass tube is inserted; underneath is placed a beaker or basin of convenient size containing water, under the surface of which the glass tube dips. Into the tube, D, the stem



of a second funnel, E, is inserted; both funnels are conveniently supported in the rings of a retort stand.

The apparatus is used in the following manner: A piece of fine calico is placed inside the metal cone, and the wooden top cemented to the funnel, A, by means of almond meal made into a stiff lute with water to which a little glycerine has been added. The tube, D, is closed, and a current of coal gas, carbonic anhydride or other suitable gas is passed through the funnel by the tubes, B and C, to displace atmospheric air. The precipitate to be treated is poured into the funnel, E, and by means of the clip at D rapidly transferred to the funnel, A. When the bulk of the water has passed through the funnel, the tube, F, is closed by a clip, and the funnel, A, filled with boiled water through the funnel, E. After the lapse of a few minutes the water is run off and the operation repeated till the precipitate is practically free from soluble salt. The tube, C, is now closed and the precipitate allowed to drain.

It is desirable to maintain a gentle current of gas while the washing is being carried through; and when the tube, C, is closed, the resulting pressure guards against the entrance of atmospheric air through any flaw in the connections.

Ferrous carbonate is the only salt I have had occasion to treat in this way, the wash bottle referred to being used to precipitate the carbonate. With some slight modification of the funnel, A, however, I believe the above arrangement could be conveniently used both for precipitating and washing such unstable salts as ferrous carbonate, ferrous phosphate, etc.—*Chem. and Drug.*

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